

BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Modifications to the BCMASP Simulator
for Saturn IB Trajectories - Case 610

DATE: March 29, 1968

FROM: I. Hirsch

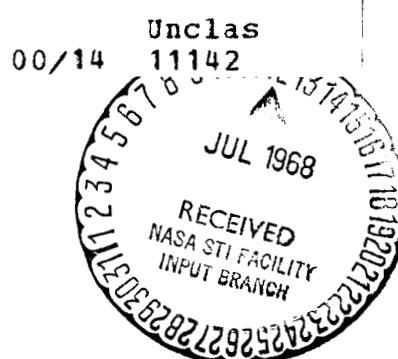
ABSTRACT

Several changes have been made in the BCMASP (Bellcomm Apollo Simulation Program) simulator for Saturn IB earth-orbital missions. The most significant modification was the adjustment of the first-stage thrust model to correct an apparently systematic discrepancy between BCMASP and Chrysler Corporation trajectories. With the new thrust function BCMASP-calculated payloads agree to within .5% of those by Chrysler for mission altitudes of interest to AAP, viz. 81 to 260 nm.

Other modifications to the program include the option to simulate SLA/Nose Cone jettison during powered flight as is currently baselined for unmanned AAP flights.

(NASA-CR-95417) MODIFICATIONS TO THE BCMASP
SIMULATOR FOR SATURN 1B TRAJECTORIES
(Bellcomm, Inc.) 36 p

N79-71997



FF No. 602(A)

~~V 200-12032~~

SESSION NUMBER	(THRU)
16	None
(PAGE)	(CODE)
CR 95417	
(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)
AVAILABLE TO NASA OFFICES AND NASA RESEARCH CENTERS ONLY	

BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Modifications to the BCMASP Simulator
for Saturn IB Trajectories - Case 610

DATE: March 29, 1968
FROM: I. Hirsch

MEMORANDUM FOR FILE

I. INTRODUCTION

A computer program extending the capability of the BCMASP simulator to handle Saturn IB trajectories has been reported in Reference 1. The simulator is currently being used for a variety of engineering studies of AAP missions. Where possible, checks against Preliminary Reference Trajectories (PRT's) generated by Chrysler Corporation for MSFC are made to establish a satisfactory level of confidence in the validity of the BCMASP simulator output. Such tests revealed an apparently systematic discrepancy with increasing orbital altitude between the simulator output and the Chrysler trajectories.

It was quickly determined that the BCMASP simulator output is very sensitive to the booster thrust model used. While it is recognized that propulsion tapes generated from test data and a computer model of the booster propulsion system by the P & VE Laboratory of MSFC are used in the production of the PRT, an effort was undertaken to synthesize an analytical representation of the booster propulsion performance which would yield simulator results more consistent with the PRT's.

In addition to modifying the thrust function, an option was incorporated into the BCMASP simulator which permits the simulation of AAP missions which have the SLA/Nose Cone jettisoned during boost. These and other changes made to the simulator are detailed below.

II. MODIFICATIONS IN THE THRUST EQUATION

At liftoff the H-1 engines of the S-IB stage are not producing full rated thrust. The pumps, etc. continue to accelerate for a short time. In addition, as the ambient pressure drops with increasing altitude, a "pressure component" of thrust is added. This thrust buildup of the first stage is implemented in the simulator with the use of an exponential function of time in the thrust equation for the first 32 seconds of flight according to

$$\text{THRUST} = C_1 \cdot \left[1 - e^{-(C_2 + C_3 t)} \right] + C_4 \cdot (P_0 - P), \quad 0 \leq t \leq 32 \quad (1)$$

P and P_0 denote the ambient and sea level atmospheric pressures respectively, and t is the time from launch. The exponential term in (1), $C_1 \cdot [1 - e^{-(C_2 + C_3 t)}]$, replaces a quadratic function of time used previously and results in a more rapid build-up of the thrust. The constants C_1 , C_2 , and C_3 which appear in (1) are characteristic of the performance capabilities of the booster first stage and were selected to achieve a high degree of agreement between the thrust profiles of the PRT and the BCMASP simulation of the PRT. C_4 was determined from similar considerations and reflects the total nozzle-exit-plane area of the eight H-1 engines.

From 32 seconds until approximately 100 seconds after liftoff, the thrust function is given simply by

$$\text{THRUST} = C_5 + C_4 \cdot (P_0 - P), \quad 32 \leq t \leq 100 \quad (2)$$

where C_5 is equal to $C_1 \cdot [1 - e^{-(C_2 + C_3 t)}]$ at 32 seconds to insure a smooth transition from (1) to (2).

Toward the end of the first-stage burn, reduced LOX density due to heating and stratification in the long cylindrical tanks causes a reduction in thrust. Another contributing factor is a drop in net suction head pressure at the turbopump inlet due to decreasing quantities of propellant remaining in the tanks. Therefore, for the duration of the first stage powered flight after 100 seconds, an additional term had been added to (2) in Reference 1 to simulate this decrease in thrust. The use of this term has been retained in the thrust function along with the same set of matching constants.

The BCMASP subroutines, "SIMTGT" and "DIFEQ", in which the above changes were instituted can be found in Appendix B. Figure 1 shows the net results of the modified composite thrust function in a BCMASP simulation of the 209 PRT (Reference 3).

Determining a set of constants to generate a first-stage thrust function for each vehicle currently assigned to the AAP program poses a formidable problem. However, because of the relatively small differences in the first-stage engine performance data for Vehicles 207 through 212 (shown in Table I), a single

first-stage thrust function (or equivalently, a standard first-stage launch vehicle) should serve quite satisfactorily in carrying out mission analysis studies for Vehicles 207 through 212.

Simulations made using a standard first-stage thrust function have resulted in payloads differing by less than .5% from studies made by Chrysler (Reference 2) as will be seen in Section V below. For "in-house" studies, MSFC has found a thrust function of the form shown in equation (2) for the entire first-stage powered flight to satisfactorily meet their needs. Since the thrust profile pictured in Figure 1 appears to more closely simulate the actual flight conditions of a Saturn IB vehicle, the thrust function used to generate it will continue to be used in future Bellcomm AAP studies.

III. MODIFICATIONS IN THE DRAG EQUATION

The drag equation used in the simulator has been modified to

$$\text{DRAG} = \frac{1}{2} C_D \rho A V_a^2 + \frac{1323.}{1 + M^4}$$

where C_D = drag coefficient, ρ = local atmospheric density, V_a = magnitude of relative velocity of air mass to vehicle, A = cross-sectional area of vehicle, M = Mach number. The second term in the drag equation compensates for a drag force of 1323 pounds at liftoff in the PRT's. The resultant drag profile for a BCMASP simulator run and the deviation from the PRT (Reference 3) are shown in Figure 2.

IV. UTILIZATION OF A VARIABLE FIRST-STAGE WEIGHT RATE IN THE SIMULATOR

Data from the weight profile in the 209-PRT (Reference 3) was used to compute the first-stage weight-rate profile until inboard engine cut-off (IECO) in Figure 3. The incorporation of a weight-rate table into the BCMASP simulator resulted in no overall improvement in duplicating payload studies of Chrysler (Reference 2), so use of the constant weight rate which yielded good results has been retained in the BCMASP simulator. Although the areas (or weights) under the constant weight-rate line (used in the BCMASP simulation of the 209-PRT) and the weight-rate curve for the 209-PRT in Figure 3 are obviously not equal, the difference in weights is compensated for by a somewhat larger weight rate used in the 209-PRT from IECO to outboard engine cut-off (OECO) than the 3207.8 pounds per second used in the BCMASP simulator.

The buildup in weight rate early in the flight reflects the continued increase in turbopump speed during this period, while the decrease in weight rate later is the manifestation of the LOX density decrease mentioned above. The shaded peak in Figure 3 with an area of roughly 1050 pounds apparently comes from the dissipation of some 1100 pounds of frost which is present on the vehicle at liftoff.

Utilization of a weight-rate function in the simulator offers considerably more flexibility than that of a weight-rate table; however, the recurrent problem of determining a set of coefficients for such a function which would work in all cases would have to be dealt with. Future use of a weight-rate function in the BCMASP simulator is contemplated by the author.

V. COMPARISON OF BCMASP SIMULATOR WITH OTHER SIMULATORS

The validity of the BCMASP simulator can best be judged by comparing its results with those of other simulators of at least the same level of sophistication. Comparison studies between the BCMASP simulator and Chrysler's for Vehicle 209 are summarized in the following chart:

Orbit (n.mi.)	Payload-BCMASP (pounds)	Payload-Chrysler (Reference 2) (pounds)	Δ (Payload) (pounds)
81 x 81	41731	41700	+ 31
150 x 150	37233	37200	+ 33
200 x 200	33302	33250	+ 52
260 x 260	28053	28150	- 97

Using the same first stage (constant) weight rate and thrust function in the BCMASP simulator for Vehicle 207 as was used in the above simulations for Vehicle 209 again resulted in payload differences of less than .5% as shown by:

81 x 120	40336	40200	+136
150 x 150	36216	36150	+ 66
200 x 200	32344	32300	+ 44
260 x 260	27194	27300	-106

where the columns retain the same meaning used above. Weight and engine performance data used in the above comparison studies was assembled from References 2-4.

Good agreement was also reached with simulations made by MSFC's "in-house" simulator for Vehicles 208 (Reference 5) and 210 (Reference 6), thereby strengthening the argument for use of a standard first-stage thrust function. A print-out of the trajectory flown by the BCMASP simulator for the 209-PRT model is given in Appendix B.

All simulations were made using the maximum dynamic pressure mode of the BCMASP subroutine "ETHORB" (c.f. Reference 1). Little, if any, difference resulted in the trajectories when using the (alternate) standard form of "ETHORB" which uses the time of LES jettison in the targeting phase of the simulation.

VI. MODIFICATIONS TO THE BCMASP SIMULATOR REQUIRED BY CHANGES IN THE AAP BASELINE

The present AAP baseline calls for SLA/Nose Cone jettison on unmanned missions. A slight change in the simulator permits such missions to be flown with or without SLA/Nose Cone jettison by simply setting "WGTLES" in the data deck equal to the weight of the SLA/Nose Cone assembly or zero respectively. In the manned configuration, "WGTLES" will continue to represent the weight of the Launch Escape System (LES). The changes were effected in such a way to permit the continued use of distinct drag coefficient tables for the unmanned and manned launch vehicle configurations.

Additional changes will be made in the simulator as required by changes in the AAP baseline.



1021-IH-dcs

I. Hirsch

Attachments

- References
- Appendix A
- Appendix B
- Figure 1
- Figure 2
- Figure 3
- Table I

BELLCOMM, INC.

References

1. Esposito, V. J., "A Computer Program for Simulating Uprated Saturn I Trajectories," Bellcomm Technical Memorandum, TM-67-1021-2, September 29, 1967.
2. CCSD, "Preliminary Flight Profile/AAP-1,-2,-3,-4 Launch Vehicles," TN-AP-67-173, February 14, 1967.
3. CCSD, "Launch Vehicle Preliminary Reference Trajectory; AAP-2 Mission," TN-AP-67-198, April 14, 1967.
4. CCSD, "Launch Vehicle Preliminary Reference Trajectory; AAP-1 Mission," TN-AP-67-186, March 14, 1967.
5. MSFC, "Uprated Saturn I preliminary performance trajectory to a 230 nautical mile circular orbit", Memorandum R-AERO-DAP-74-67, December 28, 1967.
6. MSFC, "Uprated Saturn I preliminary performance trajectory to a 210 nautical mile circular orbit", Memorandum R-AERO-DAP-74-67, January 3, 1968.
7. MSFC, "Engine specific impulse and thrust for application to Saturn vehicles", Memorandum R-P & VE-67-401, August 23, 1967 (CONFIDENTIAL).

APPENDIX A

LISTING OF RUN/DATA DECK AND SUBROUTINES MODIFIED IN THE
BCMASP SIMULATOR (REFERENCE 1) FOR SATURN IB TRAJECTORIES
(Changes to the Subroutines Are Enclosed in Boxes)

RUN/DATA DECK

RUN JETSL9,TH1TH1,7,100
HDS VEH 209 PRT 260 X 260
MSG PLEASE RETURN OUTPUT TO FOB 10
MSG FOLLOWING RUN REQUIRES TAPE 1458
MSG FOLLOWING RUN REQUIRES TAPE 1911
ASG J=1458
ASG E=1911
XQT C112
IN J
XQT BCNASP

TARGET AREA 5,6

PRINT LATER

PGHEAD=*SATURN 1P LAUNCH TRAJECTORY STUDY*

C
C LAUNCH VEHICLE PARAMETERS

WGT1=1272541.
FUEL1=884546.
FUEL2=227793.
WGT2A=286182.
WGTLFS=0.
WGTLSG=220.
AT1=13676.2
XAREA1=360.

C ENGINE PERFORMANCE PARAMETERS

TSL1=1683370.
DWGT1=6415.6
THR2A=205000.
THR2B=230000.
THR2C=190000.
DWGT2A=480.094
DWGT2B=542.325
DWGT2C=443.438

C MISSION SPECIFIC PARAMETERS

DATEL=2439916.5
AL=82.6
PADLAT=28.532
PADLON=-80.565
PADRAD=20909891.73
DLTH1=-.23798
DLTH2=.1876
DTH2=-.22347
DPSI2=0.
DLPSI2=0.
ALT3R=311351.
FLT(072)=5.1
FLT(022)=22505528.19
REO=22505528.19
BTA4R=0.

C EVENT TIMING PARAMETERS

TIMEL=0.
TKICK=10.
VEH(69)=100.
VEH(68)=129.374
TENG5=136.374
TC2=6.0

RUN/DATA DECK

TMIX1=1.3
TJTISG=10.
TJTLES=29.85
TMIX2=205.
TC3=100.

C TOLERANCES AND OTHER PARAMETERS

ACCO1=2.9265
DFDA1=-25280.
DDWDA1=0.
DRF4=250.
QALT3=0.01
QRFA4=0.001
QWGT4=1.
K1=1
K2=1
BKPC(47)=1
BKPC(48)=0

C OPTION SELECTION FOR TARGETING

IOPTEC=1

LAST

TERM

PROCESS

LAST

END

* FIN

SIMTGT

```

EQUFOR C1,C2,C3,C7
SUBROUTINE SIMTGT
EQUIVALENCE          (VEH(1),TSL1),
•(VEH(3),DWGT1),     (VEH(4),FUEL1),
•(VEH(6),THR2A),    (VEH(7),WGT2A),
•(VEH(9),FUEL2),    (VEH(10),TC3),
•(VEH(12),WGT3),    (VEH(16),THR20),
EQUIVALENCE          (VEH(13),DWGT3),
•(VEH(53),WGTLES),  (VEH(51),XAREA1),
•(VEH(57),TMIX1),   (VEH(54),WGTISG),
•(VEH(60),TJTISG),  (VEH(58),DWGT2B),
•(VEH(63),DWGT2C),  (VEH(61),TJTLES),
•(VEH(69),TDK),     (VEH(64),THR2C),
•(VAR(368),QMAX),   (VEH(50),ACC01),
•(VAR(369),TMAX),   (VAR(370),QSUM)

```

C

C EQUIVALENCES FOR UPRATED SATURN I VEHICLE

C

```

EQUIVALENCE          (FLT(022),RAPOGR), (VAR(375),RAPOG)
DIMENSION            TQ(4),           Q(4)

```

C

C LAUNCH VERTICALLY FROM THE SURFACE OF THE EARTH.

C

EVENT LAUNCH(START)

CRITERION(T=0.)

WS1OFF=WGT1-FUEL1

WGT=WGT1

CALL ELINIT

CALL SITB(1)

AUXEQ

FOFT = - 1683370.*EXP(-(32.738+ T)/10.489)
THRN = TSL1 + FOFT

C

C INITIATE THE GRAVITY TURN.

C

EVENT KICK(LAUNCH)

CRITERION(T=TKICK)

CALL IKICK

C

C BELAY THRUST BUILDUP FUNCTION

C

EVENT BELAY(KICK)

CRITERION(T=32.)

THRN = TSL1 - 1683370.*EXP(-(32.738+32.)/10.489)

DO 100 I=1,3

TQ(I)=0.

100 Q(I)=0.

QMAX=0.

AUXEQ

IF(QMAX.NE.0.) GO TO 9910

Q(4)=(RHOA*VA**2)/288.

TQ(4)=T

DO 200 I=2,4

TQ(I-1)=TQ(I)

200 Q(I-1)=Q(I)

SIMTGT

```
IF(Q(1).EQ.0.) GO TO 9910
CALL INTMAX (1,TQ,Q,TMAX,QMAX,QSUM)
IF(QMAX.EQ.0.) GO TO 9910
WRITE(6,101) TQ(3),Q(3),TMAX,QMAX
101 FORMAT(5H TQ =E15.8,3X,4H Q =E15.8,3X,7H TMAX =E15.8,3X,
     •7H QMAX =E15.8)

C
C      BEGIN THRUST DECAY
C
EVENT THRDK(KICK)
CRITERION(T=TDK)
ACCO=ACCO1
DFDA=DFDA1
AUXEQ
C
C      END GRAVITY TURN.
C
EVENT ENDGT(LAUNCH)
CRITERION(T=TEGT)
IGT=0
OMEGAP=0.
OMEGAY=0.
AUXEQ
C
C      SHUT DOWN THE CENTER ENGINES.
C
EVENT IBOFF(KICK)
CRITERION(T=TENG5)
CALL SITB(2)
IDRAG=0
AUXEQ
C
C      SHUT DOWN THE STAGE ONE ENGINES.
C
EVENT S1OFF(KICK)
CRITERION(WGT=WS1OFF)
TSAV=T+TC2
ITHR=0
C
C      START THE STAGE TWO ENGINES.
C
EVENT S4ON(S1OFF)
CRITERION(T=TSAV)
WGT=WGT2A
ITHR=1
CALL SITB(3)
TSAV1=T+TMIX1
TSAV2=T+TJTISG
TSAV3=T+TJTLES
TSAV4=T+TMIX2
WS4OFF=WGT2A-FUEL2-WGTLES-WGTISG
C
C      FIRST S-IVB MIXTURE RATIO SHIFT.
C
EVENT MIX1(S4ON,S4OFF1)
```

SIMTGT

```
CRITERION(T=TSAV1)
    CALL SITB(4)
C
C      JETTISON THE INTERSTAGE.
C
EVENT JETISG(S4ON,S4OFF1)
CRITERION(T=TSAV2)
    WGT=WGT-WGTISG
C
C      JETTISON THE LAUNCH ESCAPE SYSTEM.
C
EVENT JETLES(S4ON,S4OFF1)
CRITERION(T=TSAV3)
    WGT=WGT-WGTLES
    OMEGAP=DTH2
    CALL IPITCH(DLTH2)
    OMEGAY=DPSI2
    CALL IYAW(DLPSI2)
AUXEQ
    V=VALUE(VX)
    VCIR=SQRT(GME/R)
    VOFF=VCIR*SQRT(2./(1.+R/RAPOGR))
C
C      SECOND S-IVB MIXTURE RATIO SHIFT.
C
EVENT MIX2(S4ON,S4OFF1)
CRITERION(T=TSAV4)
    CALL SITB(5)
C
C      WEIGHT IS EQUAL TO WEIGHT WS4OFF
C
EVENT EMPTY(S4ON,S4OFF1)
CRITERION(WGT=WS4OFF)
C
C      SHUT DOWN THE STAGE TWO ENGINES.
C
EVENT S4OFF1(JETLES)
CRITERION(V=VOFF)
    V=VALUE(VX)
    ITHR=0
    OMEGAY=0.
    OMEGAP=0.
    TSAVE=T+TC3
    BETAI=BETA(RX,VX)
AUXEQ
EVENT STOP(S4OFF1)
CRITERION(T=TSAV)
LAST
END
```

DIFEQ

(PARTIAL LISTING)

***** COMPUTE DRAG LIFT AND THRUST

150 CONTINUE
 DRAG=0.
 FLIFT=0.
 THRUST=0.
 DWGT=0.
 IF (ITHR .EQ. 0) GO TO 156
 THRUST=THRDN
 IF (ITHR .EQ. 1) GO TO 153
 IF (ITHR .EQ. 2) GO TO 155
 TEMP1=T-TREF
 IF (ITHR .EQ. 3) GO TO 153
 IF (ITHR .EQ. 4) GO TO 155
 CALL LOOKUP(1,DWTSPT,TEMP,DWGT,TEMP1,LSTDWT)
 IF (ITHR .EQ. 5 .OR. ITHR .EQ. 7) GO TO 154
 IF (ITHR .NE. 6) GO TO 5050
 FISP=DWGT
 151 DWGT=THRUST/FISP
 GO TO 156
 153 DWGT=DWGTN
 154 FISP=THRUST/DWGT
 GO TO 156
 155 FISP=FISPN
 GO TO 151
 156 IF ((IDRAG .EQ. 0) .AND. (IRENT .EQ. 0) .AND. (ITHEN .EQ. 0)) GO TO 167

***** CALCULATE VELOCITY OF AIR MASS

VA2=0.
 TEMP(1)=OMEGA*(-RTX(2))
 TEMP(2)=OMEGA*RTX(1)
 TEMP(3)=0.
 CALL RCTER(1,TEMP,TEMP)
 DO 161 I=1,3
 VAX(I)=VX(I)-TEMP(I)
 161 VA2=VAX(I)**2+VA2
 VA=SQRT(VA2)
 CALL ATP
 IP=0

***** CALCULATE MACH NUMBER

RHOA=RHOA*(1.+FRHOA)
 FMACH=0.
 IF (RHOA .NE. 0.) FMACH=VA/SQRT(201.6*PRESSA/RHOA)
 IF (FMACH .LT. 1.0E-7) FMACH=0.

***** LOOKUP DRAG COEFF. AND COMPUTE DRAG FORCE

CALL LOOKUP(1,DRAGTB,TEMP,CD,FMACH,LASTCD)
 TEMP1=RHOA*VA2/2.
 DRAG=XAREA*TEMP1*CD*(1.+ECD)
 IF (IRENT .NE. 0) GO TO 169
 DRAG=DRAG+1323./ (1.+1000.*FMACH**4)
 TEMP2=DTOR*(90.-BETA(RAX,VAX))

DIFEQ

(PARTIAL LISTING)

DAH1=VA*TEMP1/(144.*((PT/2.-TEMP2))) 023300E1
160 IF((ITHEN.EQ.0).OR.(ITHR.EQ.0)) GO TO 167 023400E1
C
C COMPUTE THRUST FUNCTION FOR S1 023500E1
C
THRUST=(THRUST+AT*(PRESS0-PRESSA)-DEDA*(IDRAG/WGT+ACCO))/((1.- 023600E1
1 DEDA/WGT)
DWGT=DWGT+DD*DAK*((THRUST-DRAG)/WGT+ACCO) 023700E1
C
C

SITB

SUBROUTINE SITB(I)

```
COMMON /C1/VAR(375)/C6/VFH(100)          S1B 0003
COMMON /TABLE1/DRAGTB( 52)/TABLE2/CL1FTB( 52)/TABLE3/THRSTB( 52)/ S1B 0004
1TABLE4/DWGTSP( 52)/TABLE5/CGRVTR( 52)/TABLE6/CPRSTB( 52)    S1B 0005
S1B 0006
S1B 0007
```

EQUIVALENCE	(VAR(96), T),	(VAR(191), AT),	S1B 0008
1(VAR(192), ITHEN),	(VAR(195), WGT),	(V/R(199), XAREA),	S1B 0009
2(VAR(273), THR),	(VAR(351), TREE),	(VAR(352),WCREEF),	S1B 0010
3(VAR(356), THRN),	(VAR(357), DWGTN),	(VAR(365), DFDA),	S1B 0011
4(VAR(366), DWDIA),	(VAR(367), ACC0)		S1B 0012
EQUIVALENCE	(VFH(-1), TSL1),	(VFH(-3), DECT1),	S1B 0013
1(VFH(-6), THR2A),	(VFH(-8),DWGT2A),	(VFH(-11), THR2),	S1B 0014
2(VFH(-13), DWGT3),	(VFH(-48), DFDA1),	(VFH(-49),DWDIA1),	S1B 0015
3(VFH(-50), ACC1),	(VFH(-51),XAREA1),	(VFH(-52), AT1),	S1B 0016
4(VFH(-58),DWGT2B),	(VFH(-59), THR2B),	(VFH(-63),DWGT2C),	S1B 0017
5(VFH(-64), THR2C),	(VAR(274), DRAG),	(VAR(275), ILTET),	
6(VFH(-53),WGTLES)			

S1B 0019

DIMENSION TAB11(52), TAB21(52), TAB31(52)

```
DATA TAB11/25.,0.,0.,0.,2.,25.,3.,4.,5.,6.,7.,8.,9.,25.,
11.,1.05,1.1,1.2,1.3,1.5,2.0,2.5,3.,3.5,4.,5.,6.,,
299.,1.,1.,.65,.66,.53,.48,.45,.43,.42,.45,.5,.67,.78,.77,.68,
3.61,.52,.39,.31,.25,.19,.15,.07,.01,.0/.
```

```
DATA TAB21/25.,0.,0.,0.,2.,25.,3.,4.,5.,6.,65.,75.,85.,95.,1.,
11.05,1.1,1.2,1.5,2.0,2.5,3.0,3.5,4.,4.5,5.,6.,99.,1.2,1.2,
2.9,.6,.47,.38,.31,.29,.32,.4,.54,.66,.78,.79,.76,.63,.49,.42,
3.4,.38,.36,.31,.25,.05,0.0/
```

```
DATA TAB31/25.,0.,0.,3281.,32808.,42651.,65617.,72178.,
1 78740.,88582.,91864.,98425.,111549.,114829.,124672.,134514.,
2 141076.,154199.,157480.,160761.,164042.,173885.,177165.,
3 183727.,190289.,193560.,262467.,0.,0.,99.43,113.19,26.25,
4 21.33,26.25,45.93,32.81,55.77,26.25,37.73,-9.84,37.73,
5 13.12,42.65,32.81,44.29,16.40,37.73,32.81,37.73,65.62,29.53,
6 164.04/
```

GO TO (100,200,300,400,500),I

ENTER S1 VEHICLE DATA

```
100 DO 5 J = 1,52
      5 THRSTB(J) = TAB31(J)
      IF(WGTLES.LT.7500.) GO TO 2
      DO 1 J = 1,52
      1 DRAGTB(J)=TAB11(J)
      GO TO 3
      2 DO 4 J=1,52
      4 DRAGTB(J)=TAB21(J)
      3 XAREA=XAREA1
```

SITB

THRN=TSL1
ITHR=1
ITHFN=1
DFDA=C.
DDWDA=DDWDA1
ACCO=0.
AT=AT1
DWGTN=DWGT1
GO TO 600

C
C CHANGE S1 DATA TO REFLECT IECO
C

200 DWGTN=.5*DWGTN
THRN=.5*THR1
AT=.5*AT
GO TO 600

C
C ENTER S2 VEHICLE DATA
C

300 DWGTN=DWGT2A
THRN=THR2A
ITHFN=C
GO TO 600

C
C CHANGE S2 VEHICLE DATA TO REFLECT MIX1
C

400 DWGTN=DWGT2B
THRN=THR2B
GO TO 600

C
C CHANGE S2 VEHICLE DATA TO REFLECT MIX2
C

500 DWGTN=DWGT2C
THRN=THR2C
600 RETURN
END

APPENDIX B

PRINT-OUT FOR BCMASP SIMULATION OF 209-PRT (REFERENCE 3)

VET-209 PILOT 200 X 260 N.W.I.

SATURN 1B LAUNCH TRAJECTORY STUDY

PAGE - 1

*****LAUNCH AT TIME .000 AFTER 0 STEPS

1	MAK.	1968	0 HR	0 MIN	.000 SEC	-1 DAY	24 HR	0 MIN	-000 SEC	.0000000
GEOCENTRIC POWERED FLIGHT										
	DATE	2459916.5U	TIME			I COUNT	.00000000	H NORM	1.00000000	ALT
RX		-1312.611710	D VIX	1.88079596	V AX	3.0517578-05	RHO A	2.2933021-03	D WGT	1272468.00
RY		277.510866	D VI Y	8.85503820	V AY	-3.8146973-06	PRESSA	14.7246709	THRUST	6415.60000
RZ		2.29287010	D VIZ	4.97018760	V AZ	-5.9604645-08	THE TA	89.8388210	OMEGA P	.00000000
R		1341.63380	D VI	10.3272386	V A	3.0755129-05	G INCL	28.3708190	OMEGA Y	.00000000
XLATC		-60.5662760	ALFA I	89.8887370	BETAA	-9.5367432-07	D NODE	90.0000000	OMEGA R	.00000000
FLIFT		1323.00000	F MACH	.00000000	BETAA	4.22789670	RP X	-7575.93750	VP X	1330.45950
CD		1.19999999	CL	.00000000	G ALPH A	6.4607482-13	QAERO	7.5318889-15	VP Y	3.6805868-06
FISP		262.380990	A XIAL A	42.5391020	ALPHA	85.7785920	APHIT	-.00000000	VP Z	58332.0000
DAHI		3.1440309-18	A HI	.00000000	DELTAV					172.796570
*****LAUNCH AT TIME .000 AFTER 0 STEPS										.0000000
1	MAK.	1968	0 HR	0 MIN	.000 SEC	-1 DAY	24 HR	0 MIN	-000 SEC	.0000000
GEOCENTRIC POWERED FLIGHT										
	DATE	2439916.5U	TIME			I COUNT	.00000000	H NORM	1.00000000	ALT
RX		-3823063.0U	V X	1.88079596	V AX	3.0517578-05	RHO A	2.2933021-03	D WGT	1272468.00
RY		18000929.0	V Y	8.85503820	V AY	-3.8146973-06	PRESSA	14.7246709	THRUST	6415.60000
RZ		99284428.5U	V Z	4.97018760	V AZ	-5.9604645-08	THE TA	89.8388210	OMEGA P	.00000000
R		20909891.0	V	10.3272386	V A	3.0755129-05	G INCL	28.3708190	OMEGA Y	.00000000
XLATC		23.531965U	XLOI,	89.8887370	BETAA	-9.5367432-07	D NODE	90.0000000	OMEGA R	.00000000
FLIFT		.00000000	DRAG	1323.00000	F MACH	.00000000	BETAA	4.22789670	RP X	-7575.93750
CD		1.19999999	CL	.00000000	G ALPH A	6.4607482-13	QAERO	7.5318889-15	VP X	1330.45950
FISP		262.380990	A XIAL A	42.5391020	ALPHA	85.7785920	APHIT	-.00000000	VP Y	3.6805868-06
DAHI		3.1440309-18	A HI	.00000000	DELTAV					58332.0000
*****LAUNCH AT TIME .000 AFTER 0 STEPS										.0097555-04
1	MAK.	1968	0 HR	0 MIN	.000 SEC	-0 DAY	0 HR	0 MIN	-000 SEC	.0000000
GEOCENTRIC POWERED FLIGHT										
	DATE	2439916.5U	TIME	E.0975552-05	I COUNT	.00000000	H NORM	6.1035156-05	ALT	
RX		3823062.9U	V X	1.53807843	V AX	1.2207031-04	RHO A	2.2933021-03	D WGT	1272467.60
RY		18000929.0	V Y	7.24139830	V AY	4.3869219-04	PRESSA	14.7246709	THRUST	6415.60000
RZ		99284428.5U	V Z	4.07417890	V AZ	2.4837255-04	THE TA	89.8388210	OMEGA P	.00000000
R		20909891.0	V	8.44999810	V A	5.1868985-04	G INCL	28.3708190	OMEGA Y	.00000000
XLATC		28.531965U	XLOI,	89.8887370	BETAA	2.2888184-05	D NODE	90.0000000	OMEGA R	.00000000
FLIFT		.00000000	DRAG	1323.00000	F MACH	4.5590077-07	BETAA	86.8604470	RP X	-7575.8750
CD		1.19999999	CL	.00000000	G ALPH A	6.7001263-12	QAERO	2.142319-12	VP X	1330.45960
FISP		250.81436U	A XIAL A	40.6918380	ALPHA	3.12751000	APHIT	-.00000000	VP Y	5.1707029-04
DAHI		7.3207920-18	A HI	1.0918522-20	DELTAV	2.3448379-03				58332.0000
*****LAUNCH AT TIME .000 AFTER 0 STEPS										.6249994-01
1	MAK.	1968	0 HR	0 MIN	.002 SEC	-0 DAY	0 HR	0 MIN	-062 SEC	.0000000
GEOCENTRIC POWERED FLIGHT										
	DATE	2439916.5U	TIME	E.2499940-02	I COUNT	.00000000	H NORM	6.2500000-02	ALT	
RX		3822981.0U	V X	1.54155165	V AX	9.7503662-02	RHO A	2.2933194-03	D WGT	6415.60000
RY		18000946.0	V Y	7.25713060	V AY	4.5908737-01	PRESSA	14.7248128	THRUST	1609697.30
RZ		99284428.6U	V Z	4.08292870	V AZ	2.5492451-01	THE TA	89.8388210	OMEGA P	.00000000
R		20909891.0	V	8.46833110	V A	5.3409238-01	G INCL	28.3708190	OMEGA Y	.00000000
XLATC		28.531965U	XLOI,	89.8886730	BETAA	2.2809982-02	D NODE	90.0003960	OMEGA R	.00000000
FLIFT		.00000000	DRAG	1323.14120	F MACH	4.6943828-04	BETAA	89.83882270		

VLT-2U3 PRT, 200 X 260 I.R.I.

SATURN IB LAUNCH TRAJECTORY STUDY

PAGE 2

CD	1.1999999	CL	0.0000000	QALPHA	1.3668922-09	QAERO	2.2714586-06	RPX	-7492.79690.	VPX	1330.45990.
FISP	250.846760	AXI ALA	40.6801710	ALPHA	6.0176849-04	APHIT	2.2888184-04	RPY	20909808.0	VPY	5.2872822-01
DAHI	7.7233239-07	AII	1.2059120-08	DELTAV	2.54353580			RPZ	58342.6250	VPZ	172.793660

1 MAR.	1968	0 HR	0 MIN	7.000 SEC	-0 DAY	0 HR	0 MIN	7.000 SEC	7.0000000		
GEOCENTRIC POWERED FLIGHT											
DATE	243910.50	TIME	7.0000000	ICOUNT	• 00000000J	HNORM	1.00000000	ALT	278.831970	WGT	1227558.80
RX	38103915.90	VX	-1300.30330	DVIX	1.97545683	VAX	12.4695282	RHOA	2.2791821-03	DWGT	6415.60000
RY	18003005.0	VY	335.242020	DVIY	9.23115310	VAY	58.3981890	PRESA	14.6089397	THRUST	1643404.00
RZ	9928583.40	VZ	34.7277160	DVIZ	5.18066570	VAZ	32.43454550	THETA	89.8367850	OMEGAP	0.0000000
R	20910119.0	V	1343.27280	DVI	10.7682827	VA	67.9546710	GINCL	28.3708220	OMEGAY	0.0000000
XLATC	28.5319900	XLOU	-80.5662780	ALFAI	89.8805470	BETAI	2.89975350	DNODE	90.0464550	OMEVAR	0.0000000
FLIFI	• 000000000	DKAG	3579.69400	F MACH	5.9779767-02	BEJAA	89.8196120				
CU	1.1999999	CL	0.0000000	QALPHA	2.0030725-03	QAERO	3.6544764-02	RPX	1737.24990	VPX	1330.45150
FISP	255.855c10	AXI ALA	42.9794350	ALPHA	5.4811478-02	APHIT	2.5732994-02	RPY	20910034.0	VPY	67.3529950
DAHI	1.58193700	AII	2.57088840	DELTAV	295.779300			RPZ	59540.1250	VPZ	172.465400

1 MAR.	1968	0 HR	0 MIN	10.000 SEC	-0 DAY	0 HR	0 MIN	10.000 SEC	10.0000000		
GEOCENTRIC POWERED FLIGHT											
DATE	243910.50	TIME	10.0000000	ICOUNT	• 00000000	H NORM	1.00000000	ALT	533.222400	WGT	1208312.00
RX	3810024.20	VX	-1294.09220	DVIX	2.16644190	VAX	18.7571870	RHOA	2.2634190-03	DWGT	6415.60000
RY	18004114.0	VY	364.231740	DVIY	10.1005639	VAY	87.6717140	PRESA	14.4797416	THRUST	1658456.70
RZ	9928611.70	VZ	50.9905360	DVIZ	5.66412260	VAZ	48.6972210	THETA	89.8346920	OMEGAP	0.0000000
R	20910373.0	V	1345.33990	DVI	11.7812200	VA	102.027352	GINCL	28.3708260	OMEGAY	0.0000000
XLATC	28.5319900	XLOU	-80.5662800	ALFAI	89.8764410	BETAI	4.34932520	DNODE	90.0467615D	OMEVAR	0.0000000
FLIFT	• 000000000	DKAG	6331.31080	F MACH	8.9840765-02	BETAA	89.8036170				
CU	1.1999999	CL	0.0000000	QALPHA	6.1465696-03	QAERO	8.1809873-02	RPX	5728.60930	VPX	1330.41730
FISP	257.965460	AXI ALA	43.9915850	ALPHA	7.5132370-02	APHIT	3.6760330-02	RPY	20910286.0	VPY	101.167774
DAHI	5.31820630	AII	12.1223524	DELTAV	429.316160			RPZ	60057.6250	VPZ	172.319490

**** EVENT-KICK AT TIME 10.000 AFTER 2 STEPS

1 MAR.	1968	0 HR	0 MIN	10.000 SEC	-0 DAY	0 HR	0 MIN	10.000 SEC	10.0000000		
GEOCENTRIC POWERED FLIGHT											
DATE	243910.50	TIME	10.0000000	ICOUNT	• 00000000	H NORM	1.00000000	ALT	533.222400	WGT	1208312.00
RX	3810024.20	VX	-1294.68340	DVIX	1.967793562	VAX	18.1659540	RHOA	2.2634190-03	DWGT	6415.60000
RY	18004114.0	VY	364.326620	DVIY	10.12994288	VAY	87.7665900	PRESA	14.4797416	THRUST	1658456.70
RZ	9928711.70	VZ	51.04337410	DVIZ	5.68709490	VAZ	48.7504250	THETA	89.7029770	OMEGAP	-6.769973-02
R	20910373.0	V	1345.93630	DVI	11.7822385	VA	102.027349	GINCL	28.3708270	OMEGAY	0.0000000
XLATC	28.5319900	XLOU	-80.5662800	ALFAI	89.8738970	BETAI	4.34736150	DNODE	90.0729710	OMEVAR	0.0000000
FLIFI	• 000000000	DKAG	6331.31050	F MACH	8.9840761-02	BETAA	89.7029740				
CU	1.1999999	CL	0.0000000	QALPHA	1.560393-07	QAERO	8.1809867-02	RPX	5728.60930	VPX	1331.01820
FISP	257.920470	AXI ALA	43.9915840	ALPHA	1.9073486-06	APHIT	3.6760330-02	RPY	20910286.0	VPY	101.166786
DAHI	5.3137016	AII	12.1223524	DELTAV	429.316160			RPZ	60057.6250	VPZ	172.337110

1 MAR.	1968	0 HR	0 MIN	10.750 SEC	-0 DAY	0 HR	0 MIN	10.750 SEC	10.7499999		
GEOCENTRIC POWERED FLIGHT											
DATE	243910.50	TIME	10.7499999	ICOUNT	• 00000000	H NORM	2.5000000-01	ALT	612.931330	WGT	1203500.30
RX	38109055.70	VX	-1293.20870	DVIX	1.96444499	VAX	19.6608120	RHOA	2.2584800-03	DWGT	6415.60000
RY	18004390.0	VY	371.989830	DVIY	10.3093524	VAY	95.5005790	PRESA	14.4392595	THRUST	1660342.40
RZ	9928751.50	VZ	55.3463950	DVIZ	5.78864480	VAZ	53.0530410	THETA	89.6587960	OMEGAP	-7.6816864-02
R	20910430.0	V	1346.78440	DVI	11.9854161	VA	111.002402	GINCL	28.3708280	OMEGAY	0.0000000

VEH-269 PHT. 260 X 260 N.M.

SATURN IB LAUNCH TRAJECTORY STUDY

PAGE 3

<u>XLAIC</u>	28.5319900	XLOI4	-80.5062800	ALFA1	89.8719030	BETAI	4.72761530	DNODE	90.0802990	OMEGAR	• 00000000
FLIFI	• 00000000	DRAG	7223.05140	F MACH	9.7773866-02	BETAA	89.6581090	RPX	6726.90620	VPX	1331.17390
CD	1.19997995	CL	• 00000000	QALPHA	1.3619558-04	QAERO	9.6624777-02	RPY	20910365.0	VPY	110.076721
FISP	250.134100	AXIALA	44.1940360	ALPHA	1.4095306-03	APHIT	3.9518356-02	RPZ	60186.7500	VPZ	172.300260
DAHI	0.62822480	AH1	10.6583020	DELTAV	462.800540						
<u>1 MAR. 1968</u>	0 HR	0 MIN	13.250 SEC		-0 DAY	0 HR	0 MIN	13.250 SEC			-13.2499999
<u>GEOCENTRIC POWERED FLIGHT</u>											
DATE	243910.50	TIME	13.2499999	1 COUNT	• 00000000	H NORM	2.5000000-01	ALT	929.073800	MGT	-1187461.20
RX	3805.626.00	VX	-1288.35390	DVIX	1.91704357	VAX	24.6006470	RHOA	2.2389019-03	DWGT	6415.60000
RY	18005353.0	VY	398.578440	DVIY	10.9496155	VAY	122.324504	PRESSA	14.2799577	THRUST	1668307.30
RZ	9928908.50	VZ	70.2789070	DVIZ	67.9854200	VAZ	89.4521870	OMEGAP	-1.0970112-01		
R	-20910769.0		1250.41530	DVI	142.093260		28.3708380	OMEGAY	000000000		
XLAIC	28.5320000	XLOI4	-80.5062720	ALFA1	89.8636330	BETAI	6.03967380	DNODE	90.1081430	OMEGAR	000000000
FLIFT	• 00000000	DRAG	10825.4971	F MACH	1.2530901-01	BETAA	89.4505420	RPX	10055.7344	VPX	1331.95740
CD	1.19999999	CL	• 00000000	QALPHA	8.4065287-04	QAERO	1.5696019-01	RPY	20910679.0	VPY	140.947700
FISP	250.036010	AXIALA	44.9091670	ALPHA	5.3558350-03	APHIT	4.8714638-02	RPZ	60617.2500	VPZ	172.176350
DAHI	14.1993603	AH1	42.1251040	DELTAV	576.234440						
<u>1 MAR. 1968</u>	0 HR	0 MIN	15.750 SEC		-0 DAY	0 HR	0 MIN	15.750 SEC			15.7499999
<u>GEOCENTRIC POWERED FLIGHT</u>											
DATE	243910.50	TIME	15.7499999	1 COUNT	• 00000000	H NORM	2.5000000-01	ALT	1324.74610	WGT	1171422.30
RX	38026.1.90	VX	-1283.63450	DVIX	1.79169029	VAX	29.3304140	RHOA	2.2144261-03	DWGT	6415.60000
RY	18006364.0	VY	426.744620	DVIY	11.5742120	VAY	150.725360	PRESSA	14.08355805	THRUST	1675552.20
RZ	-9929103.60	VZ	56.1080800	DVIZ	6.50747990	VAZ	83.8144530	IETA	89.1522380	OMEGAP	-1.4516738-01
R	2091155.0		1355.49680	DVI	13.3985010	VA	174.937900	GINCL	28.3708530	OMEGAY	000000000
XLAIC	28.5320020	XLOI4	-80.5662590	ALFA1	89.8521470	BETAI	7.41435050	DNODE	90.1427650	OMEGAR	000000000
FLIFT	• 00000000	DRAG	15480.8675	F MACH	1.5449439-01	BETAA	89.1505070	RPX	13387.1406	VPX	1333.28390
CD	1.19999999	CL	• 00000000	QALPHA	2.0070972-03	QAERO	2.3530791-01	RPY	20911071.0	VPY	173.563610
FISP	250.740650	AXIALA	45.5951810	ALPHA	8.5296631-03	APHIT	5.7917595-02	RPZ	61047.7500	VPZ	172.050790
DAHI	26.2084740	AH1	91.5143500	DELTAV	691.463570						
<u>1 MAR. 1968</u>	0 HR	0 MIN	18.250 SEC		-0 DAY	0 HR	0 MIN	18.250 SEC			18.2500000
<u>GEOCENTRIC POWERED FLIGHT</u>											
DATE	243910.50	TIME	16.2500000	1 COUNT	• 00000000	H NORM	2.5000000-01	ALT	1804.89530	MGT	1155383.30
RX	379940.8.10	VX	-1279.44750	DVIX	1.58247066	VAX	33.6479950	RHOA	2.1847726-03	DWGT	6415.60000
RY	-18007488.0	VY	456.455180	DVIY	12.1861252	VAY	180.669360	PRESSA	13.8471650	THRUST	1682377.80
RZ	9929339.60	VZ	102.821770	DVIZ	6.85952520	VAZ	100.477991	IETA	88.7578970	OMEGAP	-1.8188405-01
R	20911645.0	V	1362.31770	DVI	14.0733416	VA	209.474300	GINCL	28.3708830	OMEGAY	000000000
XLAIC	28.5320060	XLOI4	-80.5662300	ALFA1	89.8364390	BETAI	8.84297270	DNODE	90.1862790	OMEGAR	000000000
FLIFT	• 00000000	DRAG	21314.2750	F MACH	1.8531398-01	BETAA	88.7563280	RPX	16722.7500	VPX	1335.34600
CD	1.19999999	CL	• 00000000	QALPHA	3.7335294-03	QAERO	3.3287045-01	RPY	20911548.0	VPY	207.852630
FISP	260.303590	AXIALA	46.2557610	ALPHA	1.1216164-02	APHIT	6.7131042-02	RPZ	61477.6250	VPZ	171.923580
DAHI	44.3950340	AH1	178.311440	DELTAV	808.417790						
<u>1 MAR. 1968</u>	0 HR	0 MIN	22.250 SEC		-0 DAY	0 HR	0 MIN	22.250 SEC			22.2500000
<u>GEOCENTRIC POWERED FLIGHT</u>											
DATE	243910.50	TIME	22.2500000	1 COUNT	• 00000000	H NORM	5.0000000-01	ALT	2758.68990	WGT	1129720.90
RX	-3794301.70	VX	-1274.04460	DVIX	1.08921266	VAX	39.1912680	RHOA	2.1261862-03	DWGT	6415.60000
RY	18009414.0	VY	567.309390	DVIY	13.2882114	VAY	231.896010	PRESSA	13.3881277	THRUST	1692667.70
RZ	9929807.50	VZ	131.480410	DVIZ	7.49737100	VAZ	129.186370	IETA	87.9314810	OMEGAP	-2.4059033-01
R	20912599.0	V	1377.62090	DVI	15.2961926	VA	268.329700	GINCL	28.3709840	OMEGAY	0.0000000

VLT-200 PRT • 200 X 200 N.WI.

SATURN IB LAUNCH TRAJECTORY STUDY

PAGE 4

1. MAR. 1968 0 HR 0 MIN 27.250 SEC

DATE	TIME	ALFAI	BETAI	11.2243089	DNODE	90.2800480	OMEGAR	0.0000000
FLIFT	28.532010	XL01	89.7998580	BTAA	87.9302050	RPX	22073.8750	VPX
CL	*.00000000	DRAG	2.3815747-01	QAERO	5.3155268-01	RPY	20912495.0	VPY
FISP	9.7105514-01	CL	7.8756355-03	APHIT	8.1909180-02	RPZ	62164.8750	VPZ
DAHI	260.931940	AXIALA	1.4816284-02					
	90.8109750	AH1	998.929900	DELTAV				

27.249990

1. MAR. 1968 0 HR 0 MIN 27.250 SEC

DATE	TIME	ICOUNT	HNORM	ALT	WGT	1097642.90
FLIFT	2439910.50	UVIX	1.9179523-01	VAX	42.7413330	RHOA
DRX	3767941.80	VX	577.910570	VAY	302.961070	PRESSA
DRY	18012124.0	VY	171.382050	UVIZ	169.087660	THETA
DRZ	9930502.40	VZ	19.06.41776	UVI	349.575260	GINC1
DR	20914137.0	V	-80.5659230	ALFAI	17.2008800	DNODE
XLATC	28.5320430	XL01	26269.0310	FMACH	89.7280450	BTAAI
FLIFI	*.00000000	DRAG	.00000000	GALPHA	3.1182472-01	QAERO
CD	5.8462787-01	CL	49.257650	ALPHA	1.5863519-02	APHIT
FISP	281.465040	AXIALA	1123.64840	DELTAV	1243.38270	
DAHI	192.064730	AH1				

27.249990

1. MAR. 1968 0 HR 0 MIN 32.000 SEC

DATE	TIME	ICOUNT	HNORM	ALT	WGT	1067168.80
FLIFT	2439910.50	UVIX	32.0000000	VAX	1.00000000	RHOA
DRX	3767940.90	VX	-1.72.51090	UVIX	41.1354370	PRESSA
DRY	18012043.0	VY	652.001850	UVIY	378.092740	THETA
DRZ	9931475.40	VZ	213.751550	UVIZ	211.456750	GINC1
R	20915993.0	V	1495.98160	UVI	19.0135020	DNODE
XLATC	28.5320490	XL01	-60.5655040	ALFAI	89.6264130	BTAAI
FLIFI	*.00000000	DRAG	31685.8250	FMACH	3.9038607-01	QAERO
CD	4.0249811-01	CL	.00000000	GALPHA	2.6606057-02	APHIT
FISP	261.793760	AXIALA	50.8707850	ALPHA	2.1039009-02	
DAHI	350.413650	AH1	2384.22350	DELTAV	1482.04190	

32.000000

1. MAR. 1968 0 HR 0 MIN 32.000 SEC

DATE	TIME	ICOUNT	HNORM	ALT	WGT	1067168.80
FLIFT	2439910.50	UVIX	32.0000000	VAX	1.00000000	RHOA
DRX	3781903.90	VX	-1272.51090	UVIX	41.1354370	PRESSA
DRY	18015043.0	VY	652.001850	UVIY	378.092740	THETA
DRZ	9931475.40	VZ	213.751550	UVIZ	211.456750	GINC1
R	20915993.0	V	1495.98160	UVI	19.0212670	DNODE
XLATC	28.5320490	XL01	-60.5655040	ALFAI	89.6264130	BTAAI
FLIFI	*.00000000	DRAG	31685.8250	FMACH	3.9038607-01	QAERO
CD	4.0249811-01	CL	.00000000	GALPHA	2.6606057-02	APHIT
FISP	261.793760	AXIALA	50.8849350	ALPHA	2.1039009-02	
DAHI	350.413650	AH1	2384.22350	DELTAV	1482.04190	

32.000000

1. MAR. 1968 0 HR 0 MIN 37.250 SEC

DATE	TIME	ICOUNT	HNORM	ALT	WGT	1033486.92
FLIFT	2439910.50	UVIX	37.2499900	VAX	2.00000000	RHOA
DRX	3775202.00	VX	-1282.04910	UVIY	31.8642570	PRESSA
DRY	1801875.0	VY	743.949760	UVIY	469.929520	

37.249990

074-209 PRT. 200 X 260 N.MI.

SATURN 1A LAUNCH TRAJECTORY STUDY

PAGE 5

	RZ	R	XLAIC	FLIFT	CU	FISP	DAHI			
DATE	9932731.8W	V	265.790950	DVIZ	10.4580924	VAZ	263.4956660	THETA	82.9760830	OMEGAP -4.1172535-01
	20918533.0	V	1505.90700	DVI	21.2618430	VA	539.702740	GINCL	28.3739040	OMEGAY
	28.5321920	XLOI	-80.5946780	ALFA1	89.4704460	BETAI	20.8363730	DNODE	91.0373040	OMEGAR
	• JUN010000	DRAG	265.03.3360	FKACH	4.8787003-01	BETAA	82.9754610	RFX	42526.6560	VPX
	J.9021092-01	CL	• 000000000	GALPH	4.1368389-02	QAERO	1.80015534	RPY	20918389.0	VPY
	201.853270	AXIALA	52.8402180	ALPHA	2.3268209-02	APHIT	1.3834667-01	RPZ	64734.6250	VPZ
	618.007040	AHI	4630.14770	DELTAV	1752.44930				170.903180	

	1 MAR. 1968	0 HR	0 MIN	57.250 SEC	-0 DAY	0 HR	0 MIN	57.250 SEC	-0 DAY	0 HR	0 MIN	57.250 SEC
	GEOCENTRIC POWERED FLIGHT	TIME	TIME	ICOUNT	• 000000000	HINORM	2.000000000	ALT	23924.2720	WGT	905174.910	
	DATE	2439916.50			-11.7225248	VAX	-105.871414	RHOA	1.1014101-03	DWGT	6415.60000	
	RX	3748475.70	VX	UVIX	23.3409400	VAY	904.2704920	PRESSA	5.99331720	THRUST	1.799622.310	
	RY	18037720.0	VY	UVIY			512.773810	THETA	73.8549630	OMEGAP	-4.8444348-01	
	RZ	9940424.30	VZ	DVIZ	13.5969546	VAZ	1044.91660	GINCL	28.4050840	OMEGAY	• 000000000	
	R	20933703.0	V	DVI	29.4464640	VA	31.6019420	DNODE	93.2446250	OMEGAR	• 000000000	
	XLAIC	28.533530	XLOI	-80.5547370	ALFA1	88.4649220	BETAI					
	FLIFT	• 000000000	DRAG	141645.290	FMACH	9.9764781-01	BETAA	73.8546360	RFX	72431.6570	VPX	
	CU	8.5435471-01	CL	• 000000000	GALPH	1.0934646-01	QAERO	4.17560910	RPY	20933527.0	VPY	
	EISP	201.839370	AXIALA	5E.9320700	ALPHA	2.6186943-02	APHIT	2.2062206-01	RPZ	68141.0000	VPZ	
	DAHI	2778.468440	AHI	3606b.0750	DELTAV	2869.23870				169.727970		

	1 MAR. 1968	0 HR	1 MIN	8.250 SEC	-0 DAY	0 HR	1 MIN	8.250 SEC	-0 DAY	0 HR	1 MIN	8.250 SEC
	GEOCENTRIC POWERED FLIGHT	TIME	TIME	ICOUNT	• 000000000	HINORM	1.000000000	ALT	36474.0980	WGT	834603.320	
	DATE	2439916.50			-18.1567460	VAX	-267.117460	RHOA	7.2028244-04	DWGT	6415.60000	
	RX	-	-	UVIX	27.1494690	VAY	1176.19100	PRESSA	3.47426350	THRUST	1834073.40	
	RY	18052105.0	VY	DVIZ	15.9606822	VAZ	671.344890	THETA	68.5623110	OMEGAP	-4.8156470-01	
	RZ	-	-	UVIY	36.3525020	VA	1380.39160	GINCL	28.4471170	OMEGAY	• 000000000	
	R	9940935.40	VZ	DVIZ	87.7594520	BEITAI	34.17532520	DNODE	94.67831760	OMEGAR	• 000000000	
	XLAIC	20946311.0	V	UVI	1.39983584	BETAA	68.5620660					
	FLIFT	28.5348770	XLOI	-80.5414920	ALFA1	1.2028276-01	QAERO	4.76557160	RFX	91440.7980	VPX	
	CU	• 000000000	DRAG	16633.050	FMACH	2.523994-02	APHIT	2.7272606-01	RPY	20945995.0	VPY	
	FISP	b.7340447-01	CL	• 000000000	GALPH	3553.06380	DELTAV		RPZ	70004.3750	VPZ	
	DAHI	261.832370	AXIALA	64.2904130	ALPHA					169.038210		
		4169.04580	AHI	74481.9770	DELTAV							

	1 MAR. 1968	0 HR	1 MIN	17.750 SEC	-0 DAY	0 HR	1 MIN	17.750 SEC	-0 DAY	0 HR	1 MIN	17.750 SEC
	GEOCENTRIC POWERED FLIGHT	TIME	TIME	ICOUNT	• 000000000	HINORM	1.000000000	ALT	50019.0990	WGT	773655.120	
	DATE	2439916.50			-25.1234270	VAX	-470.679700	RHOA	4.0966608-04	DWGT	6415.60000	
	RX	3716052.80	VX	UVIX	32.7624950	VAY	1461.27290	PRESSA	1.79655977	THRUST	1857018.00	
	RY	18067159.0	VY	UVIY	19.3569910	VAZ	838.696670	THETA	64.1607800	OMEGAP	-4.5242175-01	
	RZ	9954104.0	VZ	DVIZ	45.5989110	VA	1749.36270	GINCL	28.5005140	OMEGAY	• 000000000	
	K	2095985.0	V	DVI	80.52313410	ALFA1	36.8230150	DNODE	96.1963840	OMEGAR	• 000000000	
	XLAIC	23.5309760	XLOI	119390.140	FMACH	87.1111510	BETAI	64.1605940				
	FLIFT	• 000000000	DRAG	• 000000000	GALPH	1.86049619	BETAA	4.35308610	RFX	110133.594	VPX	
	CU	5.2906105-01	CL	72.2028470	ALPHA	2.2532463-02	APHIT	3.2381821-01	RPY	20959442.0	VPY	
	FISP	261.832370	AXIALA	4349.13440	AHI	110310.061	DELTAV	4191.89150	RPZ	71607.2500	VPZ	
	DAHI									168.418200		

	1 MAR. 1968	0 HR	1 MIN	27.750 SEC	-0 DAY	0 HR	1 MIN	27.750 SEC	-0 DAY	0 HR	1 MIN	27.750 SEC
	GEOCENTRIC POWERED FLIGHT	TIME	TIME	ICOUNT	• 000000000	HINORM	1.000000000	ALT	67527.7780	WGT	87.7499990	
	DATE	2439916.50			-33.5216280	VAX	-761.902620	RHOA	1.6360553-04	DWGT	70949.110	
	RX	369677b.40	VX	-2030.738860	UVIX	-39.1382460	VYIY	1822.44230	PRESSA	7.4393106-01	THRUST	6415.60000
	RY	18086214.0	VY	2090.73980						1871414.00		

JUL-209 PRI. 200 X 200 N.M.

SATURN IB LAUNCH TRAJECTORY STUDY

PAGE 6

RZ	-990547.70	VZ	1054.06300	UVIZ	23.2309830	VAZ	1051.75890	THETA	59.9241290	OMEGAP -4.0564854-01
R	20977359.0	V	3132.36560	UVI	56.5259270	VA	2237.85340	GINC	28.5702200	OMEGAY .00000000
XLATC	28.5402390	XLOU	-80.4943880	ALFAI	86.4470330	BETAI	38.1876800	DNODE	97.6494480	OMEGAR .00000000
FLIFT	*00000000	DRAG	65300.53330	FRAIC	2.33732460	BETAA	59.9239980			
CD	4.4277455-01	CL	.00000000	GALPHA	5.2013203-02	QAERO	2.84491170	RPX	132922.080	VPX 2468.95730
FISP	201.839370	AXIALA	61.902210	ALPHA	1.8282800-02	APHIT	3.8592720-01	RPY	20976810.0	VPY 1920.37170
DAHI	4053.00050	AH1	163813.260	DELTAV	4921.16880		RPZ	73287.8750	VPZ 167.741660	

1 MAR 1968 -0 0 HR 1 MIN 37.750 SEC -0 DAY 0 HR 1 MIN 37.750 SEC -0 DAY 0 HR 1 MIN 37.750 SEC											
GEOCENTRIC POWERED FLIGHT											
DATE	243916.50	TIME	97.7499980	ICOUNT	0.00000000	HNORM	1.00000000	ALT	8B952.4470	WGT	645343.110
RX	3674146.00	VX	-2460.677550	DVIX	-42.5622610	VAX	-1140.16450	RHOA	5.5983084-05	DWGT	6415.60000
RY	16109123.0	VY	2513.16950	DVIY	45.3433890	VAY	2246.52380	PRESSA	2.7048619-01	THRUST	1877888.90
RZ	9975313.40	VZ	1305.36750	DVIZ	27.0310250	VAZ	1303.10640	THETA	56.1981680	OMEGAP -3.5413741-01	
R	20998719.0	V	3751.65690	DVI	67.8109660	VA	2836.33750	GINC	28.6461230	OMEGAY .00000000	
XLATC	28.5448660	XLOU	-80.4531250	ALFAI	85.8530920	BETAI	38.9195800	DNODE	98.9627300	OMEGAR .00000000	
FLIFT	*00000000	DRAG	32835.8670	FRAIC	2.87387920	BETAA	56.1980810				
CD	4.0504483-01	CL	.00000000	GALPHA	2.0598557-02	QAERO	1.56379621	RPX	159844.030	VPX 2932.43450	
FISP	261.839370	AXIALA	91.964530	ALPHA	1.3172150-02	APHIT	4.5908356-01	RPY	20998037.0	VPY 2334.06390	
DAHI	2624.11100	AH1	198255.960	DELTAV	5719.61230		RPZ	74962.0010	VPZ 167.041120		
1 MAR 1968 0 HR 1 MIN 40.000 SEC -0 DAY 0 HR 1 MIN 40.000 SEC											
GEOCENTRIC POWERED FLIGHT											
DATE	243916.50	TIME	100.000000	ICOUNT	0.00000000	HNORM	1.00000000	ALT	94371.4600	WGT	630908.010
RX	3668500.60	VX	-2558.822820	DVIX	-44.6906030	VAX	-1237.89640	RHOA	4.3503619-05	DWGT	6415.60000
RY	1811493.0	VY	2616.80210	DVIY	46.7774270	VAY	2350.56850	PRESSA	2.1273965-01	THRUST	1878678.60
RZ	9978319.00	VZ	1367.17390	DVIZ	27.9101860	VAZ	1364.86600	THETA	55.4325070	OMEGAP -3.4270200-01	
R	21004196.0	V	3906.97050	DVI	70.4581870	VA	2986.70700	GINC	28.6632490	OMEGAY .00000000	
XLATC	28.54461540	XLOU	-80.4418090	ALFAI	85.7322440	BETAI	39.0130300	DNODE	99.2329060	OMEGAR .00000000	
FLIFT	*00000000	DRAG	27918.5850	FRAIC	3.00805550	BETAA	55.4324320				
CD	3.9987778-01	CL	.00000000	GALPHA	1.6097754-02	QAERO	1.34746704	RPX	166574.430	VPX 3051.01420	
FISP	261.839370	AXIALA	94.3821300	ALPHA	1.1946678-02	APHIT	4.7733974-01	RPY	21003401.0	VPY 2434.72420	
DAHI	2562.40960	AH1	204310.640	DELTAV	5910.19020		RPZ	75337.6250	VPZ 166.880280		
1 MAR 1968 TIME 100.000 AFTER 2 STEPS											
GEOCENTRIC POWERED FLIGHT											
DATE	243916.50	TIME	100.000000	ICOUNT	0.00000000	HNORM	1.00000000	ALT	94371.4600	WGT	630908.010
RX	3668500.00	VX	-2558.822820	DVIX	-44.6767380	VAX	-1237.89640	RHOA	4.3503619-05	DWGT	6415.60000
RY	1811493.0	VY	2616.80210	DVIY	46.7510990	VAY	2350.56850	PRESSA	2.1273965-01	THRUST	1878022.70
RZ	9978319.00	VZ	1357.17390	DVIZ	27.8749050	VAZ	1364.86600	THETA	55.4325070	OMEGAP -3.4270199-01	
R	21004196.0	V	3906.97050	DVI	70.4253600	VA	2986.70700	GINC	28.6632490	OMEGAY .00000000	
XLATC	28.54461540	XLOU	-80.4418090	ALFAI	85.7322440	BETAI	39.0130300	DNODE	99.2329060	OMEGAR .00000000	
FLIFT	*00000000	DRAG	27918.5850	FRAIC	3.00805550	BETAA	55.4324320				
CD	3.9967778-01	CL	.00000000	GALPHA	1.6097754-02	QAERO	1.34746704	RPX	166574.430	VPX 3051.01420	
FISP	261.839370	AXIALA	94.3486800	ALPHA	1.1946678-02	APHIT	4.7733974-01	RPY	21003401.0	VPY 2434.72420	
DAHI	2562.40960	AH1	204310.640	DELTAV	5910.19020		RPZ	75337.6250	VPZ 166.880280		

1 MAR 1968 -0 0 HR 1 MIN 40.000 SEC -0 DAY 0 HR 1 MIN 40.000 SEC											
GEOCENTRIC POWERED FLIGHT											
DATE	243916.50	TIME	100.000000	ICOUNT	0.00000000	HNORM	1.00000000	ALT	94371.4600	WGT	630908.010
RX	3668500.00	VX	-2558.822820	DVIX	-44.6767380	VAX	-1237.89640	RHOA	4.3503619-05	DWGT	6415.60000
RY	1811493.0	VY	2616.80210	DVIY	46.7510990	VAY	2350.56850	PRESSA	2.1273965-01	THRUST	1878022.70
RZ	9978319.00	VZ	1357.17390	DVIZ	27.8749050	VAZ	1364.86600	THETA	55.4325070	OMEGAP -3.4270199-01	
R	21004196.0	V	3906.97050	DVI	70.4253600	VA	2986.70700	GINC	28.6632490	OMEGAY .00000000	
XLATC	28.54461540	XLOU	-80.4418090	ALFAI	85.7322440	BETAI	39.0130300	DNODE	99.2329060	OMEGAR .00000000	
FLIFT	*00000000	DRAG	27918.5850	FRAIC	3.00805550	BETAA	55.4324320				
CD	3.9967778-01	CL	.00000000	GALPHA	1.6097754-02	QAERO	1.34746704	RPX	166574.430	VPX 3051.01420	
FISP	261.839370	AXIALA	94.3486800	ALPHA	1.1946678-02	APHIT	4.7733974-01	RPY	21003401.0	VPY 2434.72420	
DAHI	2562.40960	AH1	204310.640	DELTAV	5910.19020		RPZ	75337.6250	VPZ 166.880280		

VH-209 PHOT. 200 X 200 N.MI.

SATURN IB LAUNCH TRAJECTORY STUDY

PAGE 7

1 MAR 1968 0 HR 1 MIN 51.750 SEC

-0 DAY 0 HR 1 MIN 51.750 SEC

GEOCENTRIC POWERED FLIGHT

DATE 2439910.50 TIME 111.749996 ICOUNT 0.00000000 HNORM 2.00000000 ALT 126629.095 WGT 555524.710

RX -3635069.10 VY -3151.07246 DVIX -56.3548640 VAX -1827.65060 RHOA 9.7912946-06 DWGT 6415.60000

RY 1314910.40 VY 3210.83650 UVIY 54.5767500 VAY 2947.04360 PRESA 5.2870826-02 THRUST 1869704.20

RZ 9990415.00 VZ 1722.38970 DVIZ 32.6960240 VAZ 1720.07730 THETA 51.8506360 OMEGAP -2.8642121-01

R 21036446.0 V 4617.19496 UVI 84.9913070 VA 3870.92220 GINCL 28.7492090 OMEGAY .00000000

XLATC 28.5543200 XLON 80.3685030 ALFAI 85.1831220 BETAI 39.1922580 DNODE 100.484467 OMEGAR .00000000

FLIFT 0.00000000 DRAG 9613.289940 FMACH 3.71006230 BETAA 51.8506050 RPX 206437.580 VPX 3759.94550

CD 3.7159751-01 CL .00000000 QALPHA 2.6875637-03 QAERO 5.0942062-01 RPY 21035291.0 VPY 3006.76140

FISP 261.839370 AXIALA 107.718372 ALPHA 5.2757263-03 APHIT 5.8522987-01 RPZ 77293.6250 VPZ 166.021240

1 MAR 1968 0 HR 2 MIN 9.374 SEC

-0 DAY 0 HR 2 MIN 9.374 SEC

GEOCENTRIC POWERED FLIGHT

DATE 2439910.50 TIME 129.374000 ICOUNT 0.00000000 HNORM 2.00000000 ALT 189318.040 WGT 442456.180

RX -3569770.40 VV -4323.17130 DVIX -77.7043170 VAX -2994.95180 RHOA 8.5147896-07 DWGT 6415.60000

RY 18214897.0 VY 4301.90080 DVIV 70.3750050 VAY 4042.87320 PRESA 4.6369025-03 THRUST 1849386.20

RZ 10032295.6 VZ 2377.40730 DVIZ 42.3110370 VAZ 2375.08630 THETA 47.66449020 OMEGAP -2.1508584-01

R 21099116.0 V 6545.85560 DVII 113.052315 VA 5563.77520 GINCL 28.8605200 OMEGAY .00000000

XLATC 28.5723270 XLON 80.2044850 ALFAI 84.5970630 BETAI 38.9254250 DNODE 101.916678 OMEGAR .00000000

FLIFT .00000000 QALPHA 4.7070745-04 QAERO 9.1520960-02 RPX 244281.630 VPX 5145.20600

CD 1.8799323-01 CL 134.416790 ALPHA 5.1431656-03 APHIT 7.9488182-01 RPY 21097048.0 VPY 4043.26130

FISP 261.839370 AXIALA 258629.430 UELTAV 8899.33590 RPZ 80207.8750 VPZ 164.675350

*** EVENT ENDG1 AT TIME 129.374 AFTER 2 STEPS

1 MAR 1968 0 HR 2 MIN 9.374 SEC

-0 DAY 0 HR 2 MIN 9.374 SEC

GEOCENTRIC POWERED FLIGHT

DATE 2439910.50 TIME 129.374000 ICOUNT 0.00000000 HNORM 2.00000000 ALT 189318.040 WGT 442456.180

RX -3569770.40 DVIX -4323.17130 VV 4301.90080 DVIV 70.3750050 VZ 4042.87320 PRESA 8.5147896-07 DWGT 6415.60000

RY 18214897.0 VY 2377.40730 DVIZ 42.3110370 VAZ 2375.08630 THETA 47.66449020 OMEGAP -1849386.20

RZ 10032295.6 VZ 6545.85560 DVII 113.052315 VA 5563.77520 GINCL 28.8605200 OMEGAY .00000000

R 21099116.0 V 80.2044850 ALFAI 84.5970630 BETAI 38.9254250 DNODE 101.916678 OMEGAR .00000000

XLATC 28.5723270 XLON 891.925510 FMACH 5.31003390 BETAA 47.6644910 RPX 244281.630 VPX 5145.20600

FLIFT .00000000 QALPHA 4.7070745-04 QAERO 9.1520960-02 RPY 21097048.0 VPY 4043.26130

CD 1.8799323-01 CL 134.416790 ALPHA 5.1431656-03 APHIT 7.9488182-01 RPZ 80207.8750 VPZ 164.675350

1 MAR 1968 0 HR 2 MIN 11.750 SEC

-0 DAY 0 HR 2 MIN 11.750 SEC

GEOCENTRIC POWERED FLIGHT

DATE 2439910.30 TIME 131.750000 ICOUNT 0.00000000 HNORM 2.00000000 ALT 199291.470 WGT 427212.720

RX 35592B2.90 VY -4510.65670 DVIX -80.137448U VAX -3181.67710 RHOA 5.8608543-07 DWGT 6415.60000

RY 16225320.0 VY 4473.03650 UVIY 73.7137770 VAY 4214.77480 PRESA 3.0811427-03 THRUST 1845822.00

RZ 1003865.6 VZ 2480.24360 DVIZ 44.2721520 VAZ 2477.92120 THETA 47.6979260 OMEGAP .00000000

R 21109056.0 V 6819.50790 DVII 117.540438 VA 5833.30860 GINCL 28.8736690 OMEGAY .00000000

XLATC 28.5723270 XLON -80.1764390 ALFAI 84.5372810 BETAI 38.8831930 DNODE 102.075577 OMEGAR .00000000

FLIFT .00000000 UKAG 419.117580 FMACH 5.66623080 BETAA 47.2111240 RPX 296767.560 VPX 5366.07450

CD 1.1675365-01 CL .00000000 QALPHA 3.3715457-02 QAERO 6.9246583-02 RPY 21106846.0 VPY 4205.21990

FISP 261.839370 AXIALA 138.980120 ALPHA 4.8688894-01 APHIT 8.2839298-01 RPZ 80598.7510 VPZ 164.48889n

DAMI 258.552220 AH1 239319.280 DELTAV 9194.69130

VET-209 PRT. 200 X 260 F.W.I.

SATURN IB LAUNCH PROJECT STUDY

PAGE 8

1. MAH. 1968 0 HR 2 MIN 16.374 SEC		-0 DAY 0 HR 2 MIN 16.374 SEC		136.374000	
GEOCENTRIC POWERED FLIGHT		ICOUNT	• 000000000	HINORM	219894.390 WGT
DATE 2439910.50 TIME -4893.00976	VX	-85.3525990 VAX	-3562.46260 RHOA	2.5990927-07 DWGT	
RX 3522657.40 VY	UVIX	86.8656660 VAY	4573.39450 PRESSA	1.2592054-03 THRUST	
RY 18261440.0 VZ	DVYI	48.4729800 VAZ	2692.13710 THETA	47.7672270 OMEGAP	
RZ 10058138.6	DVIZ	127.176851 VA	6391.76640 GINCL	28.8978620 OMEGAY	
R 21143710.0	DVI	84.4334830 BETAI	38.8626140 DNODE	102.363361 OMEGAR	
XLATC 28.5617710 XLON	ALFAI	6.46752690 BETAA	46.4614160 RPX	322613.730 VPX	
FLIFI 0.0000000 DRAG	FMA�	4.8148783-02 QAERO	3.6869825-02 RPY	5818.18770 VPY	
CD 4.9748641-02 CL	• 000000000 QALPHA	1.30591297 APHIT	8.9766121-01 RPY	4544.55730 VPZ	
FISP 261.839370 AXIALA	148.757580 ALPHA	240259.660 DELTAV	9800.98870	164.122590 RPZ	

*** EVENT 1BOFF AT TIME 136.374 AFTER 2 STEPS

1. MAR. 1968 0 HR 2 MIN 16.374 SEC		-0 DAY 0 HR 2 MIN 16.374 SEC		136.374000	
GEOCENTRIC POWERED FLIGHT		ICOUNT	• 000000000	HINORM	219894.390 WGT
DATE 2439910.50 TIME -4893.00970	VX	-46.8179210 VAX	-3562.46260 RHOA	2.5990927-07 DWGT	
RX 3522657.40 VY	UVIX	28.8507540 VAY	4573.39450 PRESSA	1.2592054-03 THRUST	
RY 18261440.0 VZ	DVYI	17.9080780 VAZ	2692.13710 THETA	47.7672270 OMEGAP	
RZ 10058138.6	DVIZ	57.8358290 VA	6391.76640 GINCL	28.8978620 OMEGAY	
R 21143710.0	DVI	84.4334830 BETAI	38.8626140 DNODE	102.363361 OMEGAR	
XLATC 28.5617710 XLON	ALFAI	6.46752690 BETAA	46.4614160 RPX	322613.730 VPX	
FLIFI 0.0000000 DRAG	FMA�	4.8148783-02 QAERO	3.6869825-02 RPY	5818.18770 VPY	
CD 4.9748641-02 CL	• 000000000 QALPHA	1.30591297 APHIT	8.9766121-01 RPY	4544.55730 VPZ	
FISP 261.839370 AXIALA	177.1706820 ALPHA	240259.660 DELTAV	9800.98870	164.122590 RPZ	
DAHI 152.236900 AH1					

1. MAR. 1968 0 HR 2 MIN 19.374 SEC		-0 DAY 0 HR 2 MIN 19.374 SEC		139.374490	
GEOCENTRIC POWERED FLIGHT		ICOUNT	• 000000000	HINORM	233925.920 WGT
DATE 2439910.50 TIME -5034.88110	VX	-47.7547160 VAX	-3703.26760 RHOA	1.4399356-07 DWGT	
RX 3522657.40 VY	UVIX	30.1917370 VAY	4663.04490 PRESSA	6.5889430-04 THRUST	
RY 18261440.0 VZ	DVYI	18.6948260 VAZ	2747.03980 THETA	47.8145950 OMEGAP	
RZ 10058138.6	DVIZ	59.5109290 VA	6557.77440 GINCL	28.9055070 OMEGAY	
R 21143710.0	DVI	84.4148690 BETAI	38.6270350 DNODE	102.453266 OMEGAR	
XLATC 28.5801940 XLON	ALFAI	6.82770710 BETAA	45.9989700 RPX	340308.160 VPX	
ELIE1 0.0000000 DRAG	55.2358170 FMA�	3.9040883-02 QAERO	2.1501242-02 RPY	5976.75490 VPY	
CD 4.9554996-02 CL	• 000000000 QALPHA	1.81575012 APHIT	9.4501019-01 RPY	4620.98900 VPZ	
FISP 261.839370 AXIALA	78.9716910 ALPHA	240619.790 DELTAV	10007.4616 RPZ	163.882690	
DAHI 91.0113490 AH1					

*** EVENT 1STOFF AT TIME 139.374 AFTER 4 STEPS

1. MAR. 1968 0 HR 2 MIN 19.374 SEC		-0 DAY 0 HR 2 MIN 19.374 SEC		139.374490	
GEOCENTRIC POWERED FLIGHT		ICOUNT	• 000000000	HINORM	233925.920 WGT
DATE 2439910.50 TIME -5034.88110	VX	-5.24240240 VAX	-3703.26760 RHOA	1.4399356-07 DWGT	
RX 3522657.40 VY	UVIX	-27.1922710 VAY	4663.04490 PRESSA	6.5889430-04 THRUST	
RY 18261440.0 VZ	DVYI	-15.0250541 VAZ	2747.03980 THETA	47.8145950 OMEGAP	
RZ 10058138.6	DVIZ	31.5064210 VA	6557.77440 GINCL	28.9055070 OMEGAY	
R 21143710.0	DVI	84.4148690 BETAI	38.6270350 DNODE	102.453266 OMEGAR	
XLATC 28.5801940 XLON	ALFAI	6.82770710 BETAA	45.9989700 RPX	340308.160 VPX	
FLIFI 0.0000000 DRAG	55.2358170 FMA�	3.9040883-02 QAERO	2.1501242-02 RPY	5976.75490 VPY	
CD 4.9554996-02 CL	• 000000000 QALPHA	1.81575012 APHIT	9.4501019-01 RPY	4620.98900 VPZ	
DAHI 91.0113490 AH1					

VLT-11-209 HKT 260 X 260 N.M.

SATURN I B LAUNCH TRAJECTORY STUDY

PAGE 9

FISP	261.633570	AXIALA	-4.5612295-03	ALPHA	1.81575012	APHIT	9.4501019-01	RPY	21140812.0	VPX	4620.98900
DAHI	91.01110420	AH1	240611.9.790	DELTAV	10007.4.4616			RPZ	81850.3750	VPZ	163.882690
1 MAR. 1968 0 HR 2 MIN 21.750 SEC											
GEOCENTRIC POWERED FLIGHT											
DATE	2439910.50	TIME	141.749990	ICOUNT	*00000000	HNORM	4.00000000	ALT	245051.330	WGT	387922.000
RX	3510682.20	VX	-5047.30460	DVIX	-5.2173245U	VAX	-3714.84470	RHOA	8.7585540-08	DWGT	.00000000
RY	18273047.0	VY	4654.06990	DVIY	-27.1653230	VAY	4599.35570	PRESSA	3.8282190-04	THRUST	.00000000
RZ	10064677.2	VZ	2713.69240	DVIZ	-15.0102092	VAZ	2711.36380	THETA	47.8525590	OMEGAP	.00000000
R	21154631.0	V	7510.03700	DVI	31.4719180	VA	6504.27830	GINCL	28.9053400	OMEAY	.00000000
XLATC	28.5857390	XL01	-80.0431066	ALFAI	84.4362790	BETAI	38.2193720	DNODE	102.451301	OMEGAR	.00000000
FLIFT	.000000000	DKAG	33.0157030	FMACH	6.92901790	BETAA	45.5895120				
CL	4.950528-UZ	CL	.000000000	QALPHA	2.9117906-02	QAERO	1.2865840-02	RPX	354504.500	VPX	5975.50850
FISP	261.839370	AXIALA	-2.7383050-03	ALPHA	2.26319500	APHIT	9.8296070-01	RPY	21151701.0	VPY	4546.19710
DAHI	54.0484840	AH1	240611.9.790	DELTAV	10007.4.4616			RPZ	82239.6260	VPZ	163.691460

1 MAR. 1968 0 HR 2 MIN 21.750 SEC											
GEOCENTRIC POWERED FLIGHT											
DATE	2439910.50	TIME	145.374480	ICOUNT	*00000000	HNORM	4.00000000	ALT	261701.290	WGT	387922.000
RX	3492354.20	VX	-5066.14480	DVIX	-5.17866290	VAX	-3732.41500	RHOA	3.912168-08	DWGT	.00000000
RY	18290403.0	VY	4755.68130	DVIY	-27.1260200	VAY	4502.30480	PRESSA	1.6274328-04	THRUST	.00000000
RZ	10074414.5	VZ	2559.32760	DVIZ	-14.9885941	VAZ	2656.99670	THETA	47.9104110	OMEGAY	.00000000
R	21171476.0	V	7440.05040	DVI	31.4212900	VA	6423.49600	GINCL	28.9050850	OMEGAR	.00000000
XLATC	28.591140	XL01	-79.9927310	ALFAI	84.4689080	BETAI	37.5880020	DNODE	102.448310	OMEGAR	.00000000
FLIFT	.000000000	DKAG	14.6490929	FMACH	7.08479570	BETAA	44.9518190				
CU	4.9416777-UZ	CL	.000000000	QALPHA	1.6918708-02	QAERO	5.7181527-03	RPX	376159.090	VPX	5973.51830
EISP	261.839370	AXIALA	-1.2149880-03	ALPHA	2.9587170	APHIT	1.04079342	RPY	21167972.0	VPY	4432.23760
DAHI	24.1782490	AH1	240611.9.790	DELTAV	10007.4.4616			RPZ	82832.3750	VPZ	163.397550

*** EVENT S40N AT TIME 145.374 AFTER 2 STEPS

1 MAR. 1968 0 HR 2 MIN 25.374 SEC											
GEOCENTRIC POWERED FLIGHT											
DATE	2439910.50	TIME	145.374480	ICOUNT	*00000000	HNORM	4.00000000	ALT	261701.290	WGT	387922.000
RX	3492354.20	VX	-5066.14480	DVIX	-17.5885840	VAX	-3732.41500	RHOA	3.912168-08	DWGT	.00000000
RY	18290403.0	VY	4755.68130	DVIY	-10.3748493	VAY	4502.30480	PRESSA	1.6274328-04	THRUST	.00000000
RZ	10074414.5	VZ	2659.32760	DVIZ	-5.14530360	VAZ	2656.99670	THETA	47.9104110	OMEGAY	.00000000
R	21171476.0	V	7440.05040	DVI	21.0587260	VA	6423.49600	GINCL	28.9050850	OMEGAY	.00000000
XLATC	28.5951140	XL01	-79.9927310	ALFAI	84.4689080	BETAI	37.5880020	DNODE	102.448310	OMEGAR	.00000000
FLIFT	.000000000	DKAG	.000000000	FMACH	7.08479570	BETAA	44.9518190				
CL	4.9416777-UZ	CL	*000000000	QALPHA	1.6918708-02	QAERO	5.7181527-03	RPX	376159.090	VPX	5973.51830
FISP	426.993710	AXIALA	23.0530300	ALPHA	2.9587170	APHIT	1.04079342	RPY	21167972.0	VPY	4432.23760
DAHI	.000000000	AH1	240611.9.790	DELTAV	20502.2380			RPZ	82832.3750	VPZ	163.397550

1 MAR. 1968 0 HR 2 MIN 26.674 SEC											
GEOCENTRIC POWERED FLIGHT											
DATE	2439910.50	TIME	146.074480	ICOUNT	*00000000	HNORM	4.00000000	ALT	267592.710	WGT	285484.880
RX	3485753.20	VX	-5089.01850	DVIX	-17.6016110	VAX	-3732.41500	RHOA	3.912168-08	DWGT	.00000000
RY	182906637.0	VY	4742.22650	DVIY	-10.3247523	VAY	4502.30480	PRESSA	1.6274328-04	THRUST	.00000000
RZ	10077867.4	VZ	2652.65750	DVIZ	-5.11638980	VAZ	2656.99670	THETA	47.9311730	OMEGAY	.00000000
R	21177353.0	V	7444.69020	DVI	21.0379340	VA	6423.49600	GINCL	28.9059680	OMEGAR	.00000000
XLATC	28.5973390	XL01	-79.9746450	ALFAI	84.4749620	BETAI	37.4012080	DNODE	102.458771	OMEGAR	.00000000

VEH-205 PRT • 200 X 260 N.MI.

SATURN II LAUNCH TRAJECTORY STUDY

FLIFI 4.9410777-02 CL 00000000 FMACH 7.0847957U BETAA 44.9725810 VPX 5993.28100
 CU 420.954710 AXIALA 00000000 QALPHA 1.6918708-02 QAERO 5.7181527-03 RPY 21173722.0 VPY 4413.31270
 FISP 0.00000000 ALPHA 2.9587717U APHIT 1.06155014 RPZ 83044.7500 VPZ 163.291500

*** EVENT JETISG AT TIME 140.674 AFTLR 3 STEPS

1 MAR. 1968 0 HR 2 MIN 26.674 SEC -0 DAY 0 HR 2 MIN 26.674 SEC 146.674480
 GEOCENTRIC POWERED FLIGHT
 DATE 2439910.5U TIME 140.674480 ICOUNT 0.0000000 HNORM 4.0000000 ALT
 RX 348575.2U VIX -5089.01E50 DVIX -19.1182450 VAX -3732.41500 RHOA 267592.710 WGT
 KY 182960057.0 VY 4742.22650 DVIVY -8.27756860 VAY 4502.30480 PRESSA 3.912168-08 DWGT
 RZ 100776507.4 VZ 6552.65750 DVIZ -3.91342740 VAZ 2656.99670 THETA 1.6274328-04 THRUST
 R 211773.5U V 7446.69020 DV1 21.1976490 THETA 47.93311730 OMEGAP
 XLATC 28.597039U XLON -79.9746450 ALFAI 6423.49600 GINCL 28.9059680 OMEGAY
 FLIFT 0.00000000 DRAG 7.0847957U BETAA 37.4012080 DNODE 102.458771 OMEGAR
 CL 4.9410777-02 CL 0.00000000 FMACH 44.9725810 .00000000
 FISP 424.09394U AXIALA 1.6918708-02 QALPHA 5.7181527-03 RPY 383937.580 VPX 5993.28100
 DAHI 0.00000000 ALPHA 2.9587717U APHIT 1.06155014 RPY 21173722.0 VPY 4413.31270
 DAHI 240619.790 DELTAV 20532.2390 RPZ 83044.7500 VPZ 163.291500

1 MAR. 1968 0 HR 2 MIN 35.374 SEC -0 DAY 0 HR 2 MIN 35.374 SEC 155.374480
 GEOCENTRIC POWERED FLIGHT
 DATE 2439910.5U TIME 155.374480 ICOUNT 0.0000000 HNORM 8.0000000 ALT
 RX 3440753.5U VIX -5255.95000 DVIX -19.2580110 VAX -3732.41500 RHOA 306555.320 WGT
 KY 162337540.0 VY 4671.96850 DVIVY -7.87234860 VAY 4502.30480 PRESSA 3.912168-08 DWGT
 RZ 10100800.2 VZ 7504.31540 DVIZ -3.67808080 VAZ 2656.99670 THETA 1.6274328-04 THRUST
 R 21216314.0 V -79.8516520 ALFAI 6423.49600 GINCL 28.9125170 OMEGAY
 XLATC 28.010022U XLON 0.0000000 FMACH 36.2070870 DNODE 102.536830 OMEGAR
 FLIFT 0.00000000 DRAG 7.0847957U BETAA 45.1132600 .00000000
 CL 4.9410777-02 CL 0.00000000 QALPHA 5.7181527-03 RPY 436730.440 VPX 6143.35570
 FISP 424.09394U AXIALA 26.3565150 ALPHA 2.95877170 APHIT 1.20219707 RPY 21211651.0 VPY 4306.68080
 DAHI 0.00000000 ALPHA 20759.6350 RPZ 84462.2500 VPZ 162.573240

*** EVENT JETISG AT TIME 155.374 AFTER 2 STEPS

1 MAR. 1968 0 HR 2 MIN 35.374 SEC -0 DAY 0 HR 2 MIN 35.374 SEC 155.374480
 GEOCENTRIC POWERED FLIGHT
 DATE 2439910.5U TIME 155.374480 ICOUNT 0.0000000 HNORM 8.0000000 ALT
 RX 3440753.5U VIX -5255.95000 DVIX -19.2691370 VAX -3732.41500 RHOA 305555.320 WGT
 KY 1833753.0 VY 4671.96850 DVIVY -7.8573310U VAY 4502.30480 PRESSA 3.912168-08 DWGT
 RZ 10100600.2 VZ 2619.622780 DVIZ -3.66998332U VAZ 2656.99670 THETA 1.6274328-04 THRUST
 R 21216314.0 V 7504.31540 DV1 21.136900 VA 6423.49600 GINCL 28.9125170 OMEGAY
 XLATC 26.010022U XLON -79.8516520 ALFAI 36.2070870 DNODE 102.536830 OMEGAR
 FLIFT 0.00000000 DRAG 7.0847957U BETAA 45.1132600 .00000000
 CL 4.9410777-02 CL 0.00000000 QALPHA 5.7181527-03 RPY 436730.440 VPX 6143.35570
 FISP 424.09394U AXIALA 26.3771630 ALPHA 2.95877170 APHIT 1.20219707 RPY 21211651.0 VPY 4306.68080
 DAHI 0.00000000 ALPHA 20759.6350 RPZ 84462.2500 VPZ 162.573240

1 MAR. 1968 0 HR 2 MIN 49.750 SEC -0 DAY 0 HR 2 MIN 49.750 SEC 169.750000
 GEOCENTRIC POWERED FLIGHT
 DATE 2439910.5U TIME 169.750000 ICOUNT 0.0000000 HNORM 16.0000000 ALT
 RX 35e3197.2U VIX -5534.71010 -19.5169860 VAX -3732.41500 RHOA 369308.370 WGT
 DAHI 0.00000000 ALPHA 20759.6350 RPZ 84462.2500 VPZ 162.573240

1 MAR. 1968 0 HR 2 MIN 49.750 SEC -0 DAY 0 HR 2 MIN 49.750 SEC 169.750000
 GEOCENTRIC POWERED FLIGHT
 DATE 2439910.5U TIME 169.750000 ICOUNT 0.0000000 HNORM 16.0000000 ALT
 RX 35e3197.2U VIX -5534.71010 -19.5169860 VAX -3.9912168-08 RHOA 3.9912168-08 DWGT

VEH-209 PRT 260 X 250 I.MI.

SATURN II LAUNCH TRAJECTORY STUDY

RY	18435959.0	VY	4563.93960	UVIY	-7.16813760	VAY	4502.30480	PRESSA	1.6274328-04	THRUST
RZ	10136053.0	VZ	2569.72220	DVIZ	-3.27075130	VAZ	2656.99670	THETA	48.3110670	OMEgap
R	21279044.0	V	7620.10710	DVI	21.0473920	VA	6423.49600	GINCL	28.9228260	OMEgAy
XLATC	26.3319110	XLOU	-79.4405606	ALFAI	84.506110	BETAI	34.3245390	DNODE	102.660957	OMEgAR
FLIFI	*.000000000	URAC	*.000000000	FACH	7.08479570	BETAA	45.3524850			
CU	4.9416777-02	CL	*.000000000	JELFLIA	1.6918708-02	QAERO	5.7181527-03	RPX	526853.000	VPX
FISP	424.093940	AXIALA	<7.1311390	ALPHA	*.9587170	APHIT	1.44140053	RPY	21272344.0	VPY
DAHL	*.000000000	AHI	240619.790	DELTAV	21144.1890			RPZ	66790.7500	VPZ

1 MAK. 1908 6.000 SEC			-0 DAY 0 HR 2 MIN 54.924 SEC			174.924490				
DATE	243910.50	TUE	174.924490	ICOUNT	.00000000	HNORM	16.0000000	ALT	391431.960	WGT
RX	333429.020	VX	-5035.94360	DVIX	-19.6114400	VAX	-3732.41500	RHOA	3.9912168-08	DWGT
RZ	13427461.0	VY	4527.50470	DVIY	-6.91380100	VAY	4502.30480	PRESSA	1.6274328-04	THRUST
R	10151346.0	VZ	2553.17810	DVIZ	-3.12356350	VAZ	2656.99670	THETA	48.3992750	OMEgap
XLATC	21301159.0	V	7606.86680	DVI	21.027100	VA	6423.49600	GINCL	28.9263840	OMEgAy
FLIFI	*.000000000	XLOU	-79.5023410	ALFAI	84.6070040	BETAI	33.6761250	DNODE	102.704208	OMEgAR
CU	4.9416777-02	DRAG	*.000000000	FMACH	7.08479570	BETAA	45.4406950	RPX	560187.080	VPX
FISP	424.093940	CL	*.000000000	QALPHA	1.6918708-02	QAERO	5.7181527-03	RPY	21293612.0	VPY
DAHL	*.000000000	AXIALA	27.4131860	ALPHA	2.9587170	APHIT	1.52960682	RPZ	87624.3760	VPZ

1 MAK. 1908 6.000 SEC			-0 DAY 0 HR 2 STEPS			174.924490				
DATE	243910.50	TUE	174.924490	ICOUNT	.00000000	HNORM	16.0000000	ALT	391431.960	WGT
RX	333429.020	VX	-5035.94360	DVIX	-15.3363112	VAX	-3732.41500	RHOA	3.9912168-08	DWGT
RZ	18427451.0	VY	4527.50470	DVIY	-4.90826320	VAY	4502.30480	PRESSA	1.6274328-04	THRUST
R	10151346.0	VZ	2553.17810	DVIZ	-2.14036190	VAZ	2656.99670	THETA	58.4933800	OMEgap
XLATC	21301159.0	V	7606.86680	DVI	16.2442180	VA	6423.49600	GINCL	28.9263840	OMEgAy
FLIFI	*.000000000	XLOU	-79.5023410	ALFAI	84.6070040	BETAI	33.6761250	DNODE	102.704208	OMEgAR
CU	4.9416777-02	DRAG	*.000000000	FMACH	7.08479570	BETAA	45.4406950	RPX	560187.080	VPX
FISP	424.093940	CL	*.000000000	GALPHA	7.463953502	QAERO	5.7181527-03	RPY	21293612.0	VPY
DAHL	*.000000000	AXIALA	27.4131860	ALPHA	13.0530854	APHIT	1.52960682	RPZ	87624.3760	VPZ

1 MAK. 1908 6.000 SEC			-0 DAY 0 HR 3 MIN 37.750 SEC			217.750000				
DATE	243910.50	TUE	217.750000	ICOUNT	.00000000	HNORM	8.0000000	ALT	568547.550	WGT
RX	307755.010	VX	-6565.90540	DVIX	-19.7860180	VAX	-3732.41500	RHOA	3.9912168-08	DWGT
RZ	10017111.0	VY	4333.17050	DVIY	-4.24480920	VAY	4502.30480	PRESSA	1.6274328-04	THRUST
R	1026949.0	VZ	2473.79470	DVIZ	-1.00726714	VAZ	2656.99670	THETA	50.8091170	OMEgap
XLATC	21476205.0	V	6104.06150	DVI	20.299560	VA	6423.49600	GINCL	28.9508420	OMEgAy
FLIFI	*.000000000	XLOU	-78.8712930	ALFAI	84.8718720	BETAI	29.7593940	DNODE	103.010169	OMEgAR
CU	4.9416777-02	DRAG	*.000000000	FMACH	7.08479570	BETAA	46.2079840	RPX	5.7181527-03	VPX
FISP	424.093940	CL	*.000000000	QALPHA	2.6311308-02	QAERO	1.52960682	RPY	2.29693030	VPY
DAHL	*.000000000	AXIALA	29.993770	ALPHA	4.60136510	APHIT	2.29693030	RPZ	94433.0010	VPZ

VEH-2U9 PKT# 260 X 200 N.MI.

SATURN IB LAUNCH TRAJECTORY STUDY

PAGE 12

1 MAR 1968 0 HR 4 MIN 57.750 SEC -0 DAY 0 HR 4 MIN 57.750 SEC
GEOCENTRIC POWERED FLIGHT
 DATE 2439910.50 TIME >97.750000 ICOUNT *0.00000000 HNORM ALT 875518.050 WGT 203332.860
 RX 2493280.50 VX -355.35510 DVIX -29.8813210 RHOA 3.9912168-08 DWGT 542.325000
 RY 13950520.0 VY 395.82660 DVIY -4.43682670 VAY 4502.30480 PRESSA 1.6274328-04 THRUST 250000.000
 RZ 13452220.1 VZ 2302.45570 DVIZ -1.35769308 VAZ 2656.99670 THETA 36.687220 OMEGAP -1.9735295-01
 R 17435036.0 V 955.90420 DV1 30.2394130 VA 6423.49600 GINCL 28.9922470 OMEGAY *000000000
 XLATC 28.84227740 XLATI 77.3136000 ALFAI 85.499750 BETAI 22.4883090 DNODE 103.576323 OMEGAR *000000000
 FLIFT *000000000 FMACH 7.08479570 BETAA 47.873930 RPX 1497066.70 VPX 9062.33390
 CL *000000000 GALPHA 6.3968468-02 QAERO 5.7181527-03 RPY 21733274.0 VPY 3040.34650
 AXIALA 36.3936770 ALPHA 11.1869116 APHIT 3.96308420 RPZ 106675.500 VPZ 148.877710

1 MAR 1968 0 HR 5 MIN 50.374 SEC -0 DAY 0 HR 5 MIN 50.374 SEC
GEOCENTRIC POWERED FLIGHT
 DATE 2439910.50 TIME 350.374490 ICOUNT *0.00000000 HNORM ALT 1061994.40 WGT 174793.280
 RX 2020554.80 VA -10139.5865 DVIX -38.2015120 RHOA 3.9912168-08 DWGT 542.125000
 RY 1915434.50 VY 3733.51460 DVIY -5.899513660 VAY 4502.30480 PRESSA 1.6274328-04 THRUST 230000.000
 RZ 10574494.2 VZ 2279.96380 DVIZ -1.88682961 VAZ 2656.99670 THETA 27.6285630 OMEGAP -1.9735295-01
 R 21971414.0 V 11043.0330 DV1 38.6997190 VA 6423.49600 GINCL 29.0130260 OMEGAY *000000000
 XLATC 28.9360250 XLATI -76.0240630 ALFAI 86.0653340 BETAI 18.0693990 DNODE 103.903084 OMEGAR *000000000
 FLIFT *000000000 FMACH 7.08479570 BETAA 49.2006970 QAERO 5.7181527-03 RPX 2017017.50 VPX 10767.7117
 CL *000000000 GALPHA 1.2335487-01 APHIT 5.28987410 RPY 21878336.0 VPY 2446.32640
 AXIALA 42.3538970 ALPHA 21.5725030 DELTAV 27215.5810 RPZ 114356.625 VPZ 142.989960

*** EVENT MIX2 AT TIME 350.374 AFTER 2 STEPS

1 MAR 1968 0 HR 5 MIN 50.374 SEC -0 DAY 0 HR 5 MIN 50.374 SEC
GEOCENTRIC POWERED FLIGHT
 DATE 2439910.50 TIME 350.374490 ICOUNT *0.00000000 HNORM ALT 1061994.40 WGT 174793.280
 RX 2008554.60 VX -10139.5865 DVIX -32.0212650 RHOA 3.9912168-08 DWGT 443.438000
 RY 1915434.50 VY 3733.51460 DVIY -9.28983930 VAY 4502.30480 PRESSA 1.6274328-04 THRUST 190000.000
 RZ 10574494.2 VZ 2279.96380 DVIZ 2656.99670 THETA 27.6285630 OMEGAP -1.9735295-01
 R 21971414.0 V 11043.0330 DV1 33.5814010 VA 6423.49600 GINCL 29.0130260 OMEGAY *000000000
 XLATC 28.9360350 XLATI -76.0240630 ALFAI 86.0653340 BETAI 18.0693990 DNODE 103.903084 OMEGAR *000000000
 FLIFT *000000000 FMACH 7.08479570 BETAA 49.2006970 QAERO 5.7181527-03 RPX 2017017.50 VPX 10767.7117
 CL *000000000 GALPHA 1.2335487-01 APHIT 5.28987410 RPY 21878336.0 VPY 2446.32640
 AXIALA 34.9731310 ALPHA 21.5725030 DELTAV 27215.5810 RPZ 114356.625 VPZ 142.989960

1 MAR 1968 0 HR 6 MIN 17.750 SEC -0 DAY 0 HR 6 MIN 17.750 SEC
GEOCENTRIC POWERED FLIGHT
 DATE 2439910.50 TIME 377.749990 ICOUNT *0.00000000 HNORM ALT 1152783.60 WGT 162653.940
 RX 1718545.00 VX -11064.2721 DVIX -35.5779210 RHOA 3.9912168-08 DWGT 443.438000
 RY 19252916.0 VY 3462.12720 DVIY -10.5980167 VAY 4502.30480 PRESSA 1.6274328-04 THRUST 190000.000
 RZ 10635332.0 VZ 2162.38510 DVIZ -4.61677040 VAZ 2656.99670 THETA 23.0035820 OMEGAP -1.9735295-01
 R 22062153.0 V 11793.2332 DV1 37.4105470 VA 6423.49600 GINCL 29.0199140 OMEGAY *000000000
 XLATC 28.985110 XLATI -75.2527630 ALFAI 86.4318170 BETAI 15.7533903 DNODE 104.026015 OMEGAR *000000000
 FLIFT *000000000 FMACH 7.08479570 BETAA 49.9782230 QAERO 5.7181527-03 RPX 2323302.20 VPX 11623.6052
 CL 4.9426777-02 CL *000000000 GALPHA 1.54247796-01 APHIT 6.06744190 RPY 21939163.0 VPY 1988.11750
 AXIALA 37.5832800 ALPHA 26.9751390 DELTAV 28207.8590 RPZ 118227.376 VPZ 139.772270

VEN-209 PHOT 200 X 200 NM.

SATURN IB LAUNCH TRAJECTORY STUDY

PAGE 13

1 MAR. 1968 0 HR 7 MIN 37.750 SEC -0 DAY 0 HR 7 MIN 37.750 SEC

GEOCENTRIC POWERED FLIGHT

DATE 243910.50 TIME 457.149990 ICOUNT 0.00000000 HNORM 8.00000000 ALT 1380101.10 WGT 127178.901
 RX -14362.2160 UVIX -47.9472630 VAX -3732.41500 RHOA 3.9912168-08 DWGT 443.438000
 RY -16.958640 VAY 4502.30480 PRESA 1.6274328-04 THRUST 190000.000
 RZ -7.76367090 VAZ 2656.99670 THETA 9.86528400 OMEGAP -1.9735295-01
 R 1032.62080 UVIZ 6423.49600 GINCL 29.03330990 OMEGAY 00000000
 R 14678.03350 UVJ 6423.49600 DNODE 104.326274 OMEGAR 00000000
 XLATC 29.141510 ALFAI 9.59836580
 FLIFT 0.00000000 FMACH 52.6277190 BETAA 52.6277190
 CD 4.9415777-02 CL 2.08479570 HEAA 5.7181527-03 RPX 3369410.60 VPX 14673.6434
 FISP 420.470270 AXIALA 42.7633710 QAERO 5.7181527-03 RPY 22032815.0 VPY 230.826210
 DAHL 0.00000000 AHI 240619.790 DELTAV 8.71707340 RPZ 129.802620 VPZ 129.802620

1 MAR. 1968 0 HR 8 MIN 37.750 SEC -0 DAY 0 HR 8 MIN 37.750 SEC

GEOCENTRIC POWERED FLIGHT

DATE 243910.50 TIME 537.749990 ICOUNT 0.00000000 HNORM 8.00000000 ALT 1537740.20 WGT 91703.8620
 RX -013613.720 VX -65.6983960 VAX -3732.41500 RHOA 3.9912168-08 DWGT 443.438000
 RY 19616014.0 VY -29.5190850 VAY 4502.30480 PRESA 1.6274328-04 THRUST 190000.000
 RZ -10694895.9 VZ -14.2143211 VAZ 2656.99670 THETA -2.53708450 OMEGAP -1.9735295-01
 R 2244698.0 V 18902.0900 DVII 73.4145920 VA 29.0374810 OMEGAY 00000000
 XLATC 29.1877190 XLATI 89.5196710 BETAA 104.537654 OMEGAR 00000000
 FLIFT 0.00000000 FMACH 56.0130260
 CL 4.9415777-02 DRAG 3.3480730-01 QAERO 5.7181527-03 RPX 4697672.30 VPX 18729.9420
 FISP 420.470270 AXIALA 5A.5516080 APHIT 12.1025582 RPY 21949393.0 VPY -2542.46010
 DAHL 0.00000000 AHI 36107.8530 DELTAV 138974.380 VPZ 119.031684

1 MAR. 1968 0 HR 10 MIN 13.539 SEC -0 DAY 0 HR 10 MIN 13.539 SEC

GEOCENTRIC POWERED FLIGHT

DATE 243910.50 TIME 613.539310 ICOUNT 0.00000000 HNORM 8.00000000 ALT 1596318.80 WGT 58096.0000
 RX -2256960.50 VX -96.6304830 VAX -3732.41500 RHOA 3.9912168-08 DWGT 443.438000
 RY -1955609E.0 VY -55.5205230 VAY 4502.30480 PRESA 1.6274328-04 THRUST 190000.000
 RZ 10907074.5 VZ -27.7788320 VAZ 2656.99670 THETA -13.3037081 OMEGAP -1.9735295-01
 R 22505535.0 V 25009.0700 DVII 114.854874 VA 29.0363330 OMEGAY 00000000
 XLATC 29.1313390 XLON -6.4.5532950 ALFAI 6423.49600 GINCL 104.662177 OMEGAR 00000000
 FLIFT *0.00000000 FMACH 7.08479570 BETAA 60.2029150
 CL 4.9416777-02 CL *0.00000000 ALPHA 4.2035484-01 QAERO 5.7181527-03 RPX 6305385.80 VPX 24007.0300
 FISP 420.471270 AXIALA 105.235371 ALPHA 73.5086520 APHIT 16.2927370 RPY -21603691.0 VPY -7007.45630
 DAHL 0.00000000 AHI 240619.790 DELTAV 42400.5440 RPZ 147585.880 VPZ 108.094306

*** LEVEL ENERGY AT TIME 613.539 AFTER 3 STEPS

1 MAR. 1968 0 HR 10 MIN 13.539 SEC -0 DAY 0 HR 10 MIN 13.539 SEC

GEOCENTRIC POWERED FLIGHT

DATE 243910.50 TIME 613.539310 ICOUNT 0.00000000 HNORM 8.00000000 ALT 1596318.80 WGT 58096.0000
 RX -2256960.50 VAX -96.6304830 VAY -3732.41500 RHOA 3.9912168-08 DWGT 443.438000
 RY -1955609E.0 VY -55.5205230 VAZ 4502.30480 PRESA 1.6274328-04 THRUST 190000.000
 RZ 10907074.5 VZ -661.040470 DVII 2656.99670 THETA -13.3037081 OMEGAP -1.9735295-01
 R 22505535.0 V 25009.0700 DVII 114.854874 VA 29.0363330 OMEGAY 00000000
 XLATC 29.1313390 XLON -64.5532950 ALFAI 6423.49600 GINCL 104.662177 OMEGAR 00000000
 FLIFT *0.00000000 DRAG 4.2035484-01 QAERO 5.7181527-03 RPX 6305385.80 VPX 24007.0300
 CL 4.9416777-02 CL *0.00000000 ALPHA 73.5086520 APHIT 16.2927370 RPY -21603691.0 VPY -7007.45630
 FISP 420.471270 AXIALA 105.235371 ALPHA 42400.5440 DELTAV 147585.880 VPZ 108.094306

VLH-209 PRT. 200 X 200 N.MI.

SATURN Ib LAUNCH TRAJECTORY STUDY

1 MAR. 1968 0 HR 10 MIN 13.542 SEC -0 DAY 0 HR 10 MIN 13.542 SEC

GEOCENTRIC POWERED FLIGHT

DATE	243916.50	TIME	613.542500	ICOUNT	• 000000000	HNORM	8.00000000	ALT	1596318.70	WGT	58094.5850
RX	-2257039.50	VX	-64375.7030	DVIX	-96.6324300	VAX	-3732.41500	RHOA	3.9912168-08	DWGT	443.438000
RY	-1955090.0	VY	-2491.06290	DVIY	-55.5222260	VAY	-4502.30480	PRESSA	1.6274328-04	THRUST	190000.000
RZ	-10907072.3	VZ	-631.129100	DVIZ	-27.7797230	VAZ	2656.99670	THETA	-13.3041354	OMEGAP	-1.9735295-01
R	22505535.0	V	25009.3970	DVI	114.857550	VA	6423.49600	GINCL	29.0363330	OMEWAY	0.00000000
XLATC	29.1313340	XLOU1	-64.5530750	ALFA1	91.7842900	BETAI	8.9645386-05	DNODE	104.6621811	OMEVAR	0.00000000
FLIEI	0.00000000	DRAG	• 000000000	FNACH	7.01849570	BETAA	60.2031180	-	-	-	-
CD	4.9416777-02	CL	• 000000000	QALPHA	4.2033844-01	QAERO	5.7181527-03	RPM	6305462-40	VPX	24007.2970
FISP	428.470270	AXIALA	105.226135	ALPHIA	73.5094820	APHIIT	16.2929400	RPY	21603668.0	VPY	-7007.70700
DATH	• 00000000	AH1	240619.790	DELTAV	42400.8800	-	RPZ	147586.120	VPZ	108.093834	-

*** EVENT STOP AT TIME 613.542 AFTER 4 STEPS

1 MAR. 1968 0 HR 10 MIN 13.542 SEC -0 DAY 0 HR 10 MIN 13.542 SEC

GEOCENTRIC FREE FLIGHT

1 MAR. 1968 0 HR 10 MIN 17.750 SEC -0 DAY 0 HR 10 MIN 17.750 SEC

GEOCENTRIC FREE FLIGHT

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542 AFTER 2 STEPS

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542490

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542490

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542490

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542490

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542490

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542490

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

*** EVENT STOP AT TIME 713.542490

1 MAR. 1968 0 HR 11 MIN 53.542 SEC -0 DAY 0 HR 11 MIN 53.542 SEC

GEOCENTRIC FREE FLIGHT

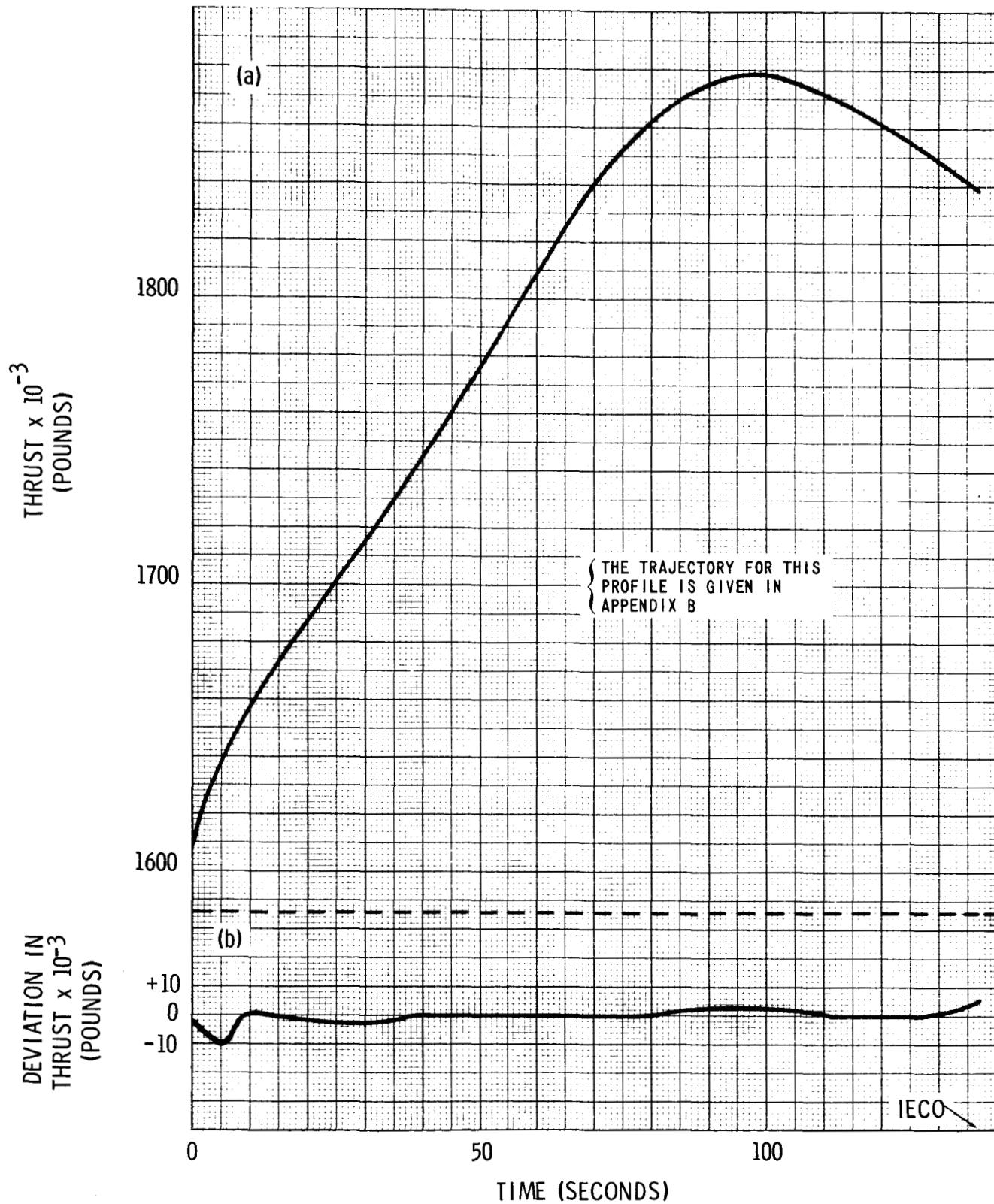


FIGURE 1 - (a) THRUST AND (b) DEVIATION IN THRUST FROM 209 PRT
VERSUS TIME FROM LAUNCH FOR BCMASP SIMULATOR

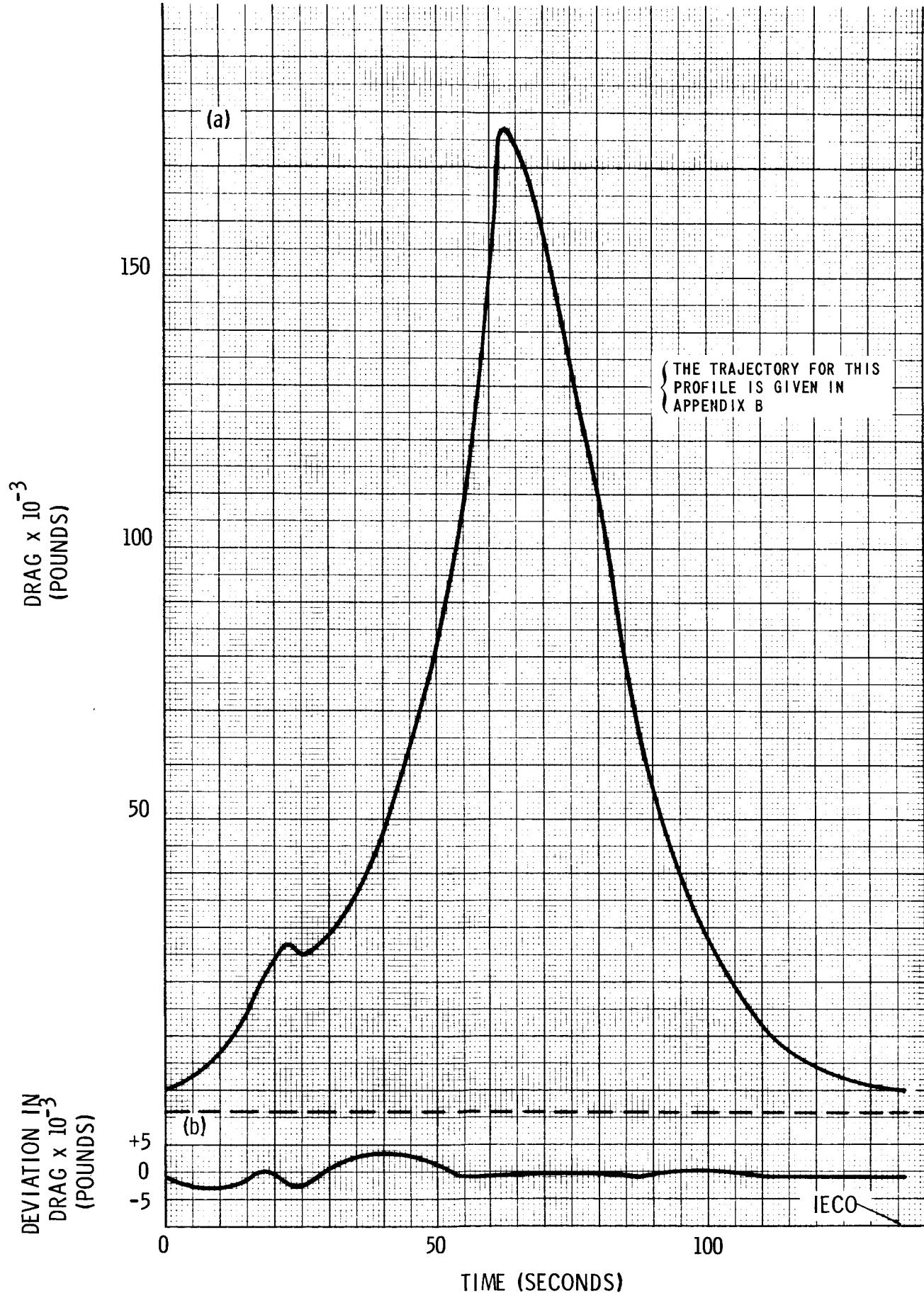


FIGURE 2 - (a) DRAG AND (b) DEVIATION IN DRAG FROM 209 PRT
VERSUS TIME FROM LAUNCH FOR BCMASP SIMULATOR

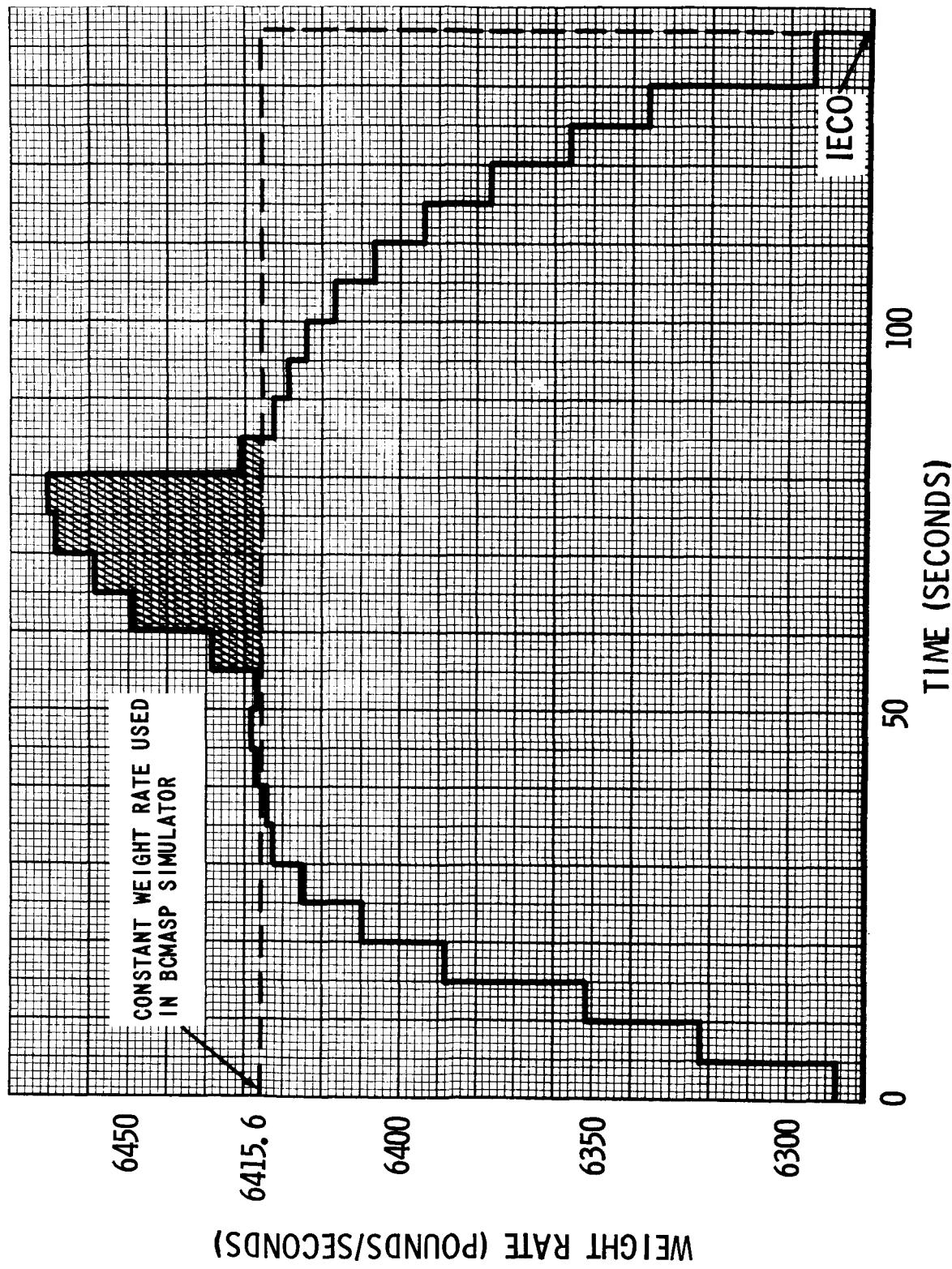


FIGURE 3 - FIRST STAGE WEIGHT RATE (UNTIL IECO) VERSUS TIME
FROM LAUNCH FOR 209 PRT (REFERENCE 3)

TABLE I

FIRST STAGE ENGINE PERFORMANCE DATA FOR SATURN IB LAUNCH VEHICLES⁵

VEHICLE	NOMINAL SEA LEVEL THRUST (POUNDS)	NOMINAL I_{SP} (SECONDS)
206	1640256	263.03
207	1656200	262.74
208	1650432	263.09
209	1650896	262.85
210	1652360	262.62
211	1652864	262.75
212	1654760	262.64

⁵Data taken from non-classified section of Reference 7.